an international monthly

THE Petroleum Engineer

Combined Edition

Drilling and Producing | Refining and Gas Processing | Oil and Gas Pipelining

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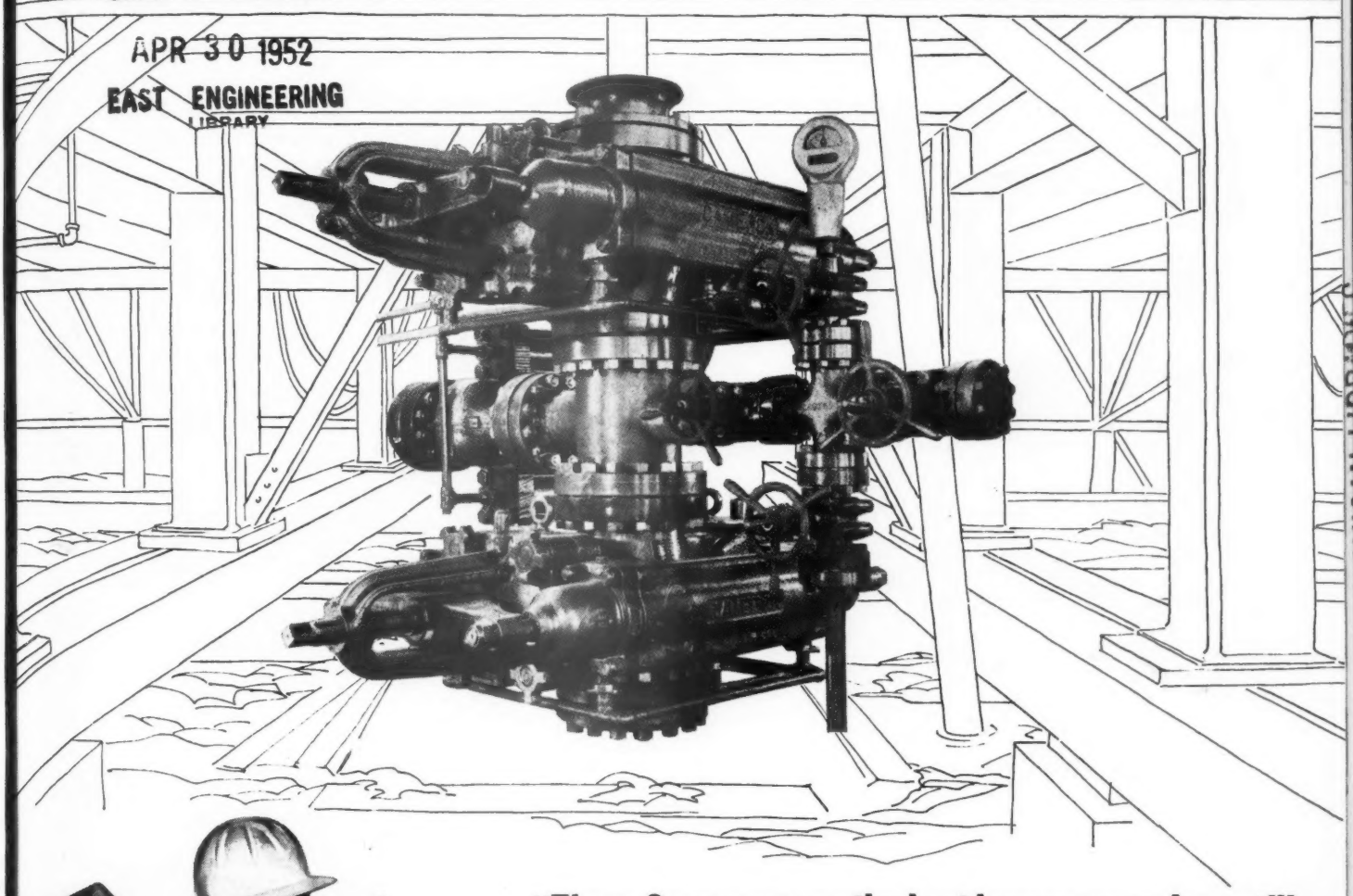

"Those Camerons are the best insurance we've got!"

No other drilling control unit offers so much protection: Swift closure of rams, remote control operating valves within easy reach of the driller, self-feeding ram packing for a positive seal and to permit pipe rotation through closed rams; closing ratio of approximately 8 to 1 (well pressure vs. closing pressure), utilization of well pressure in helping close rams, and quick ram change design which permits changing of largest size rams in a matter of minutes.

Cameron Pressure-Operated Blowout Preventers and Flowline Valves are your best *insurance* against hazardous well pressures. Before starting a wildcat or a well in a proven high pressure area, be sure your drilling control units are of adequate capacity and modern design . . . be sure they're Camerons!

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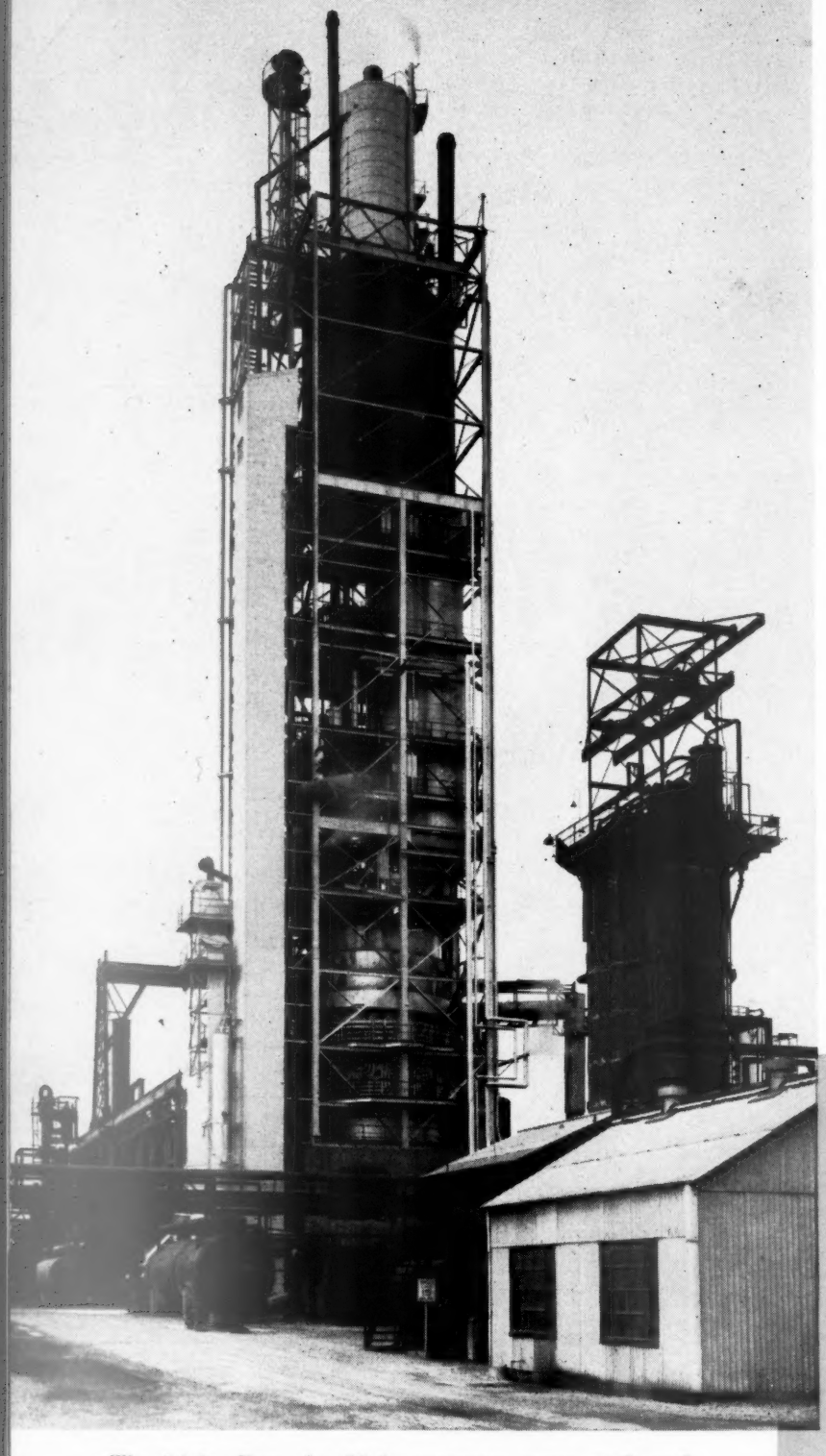
ble of Contents Page 3 • Advertisers' Index Page 6
NEW MACHINERY AND SUPPLIES E-51

APRIL 1952



The 14-ft. diam. by 35-ft. separator surge tank and the 27-ft. 6¾-in. diam. by 45-ft. 5⅝-in. single zone kiln for this T.C.C. unit at the Socony Vacuum Oil Company, Inc., Atlas Works in Buffalo. N. Y., were fabricated at our Greenville, Pa., plant.

HORTON

SURGE TANK and KILN for T.C.C. UNI

THE separator surge tank and the single zo kiln for the thermal catalytic cracking unit sho at the left were fabricated by the Chicago Brid & Iron Company. Bechtel Corporation was t general contractor on the installation, which located at the Socony Vacuum Oil Company Atlas Works in Buffalo, N. Y.

The separator surge tank—shown at the t of the T.C.C. unit—extends 250 ft. above t ground. It is designed to reduce the velocity the air-catalyst mixture flowing from the air li tube to the reactor, and to allow these componen to separate.

The single zone kiln at the bottom of the T.C. unit burns the carbonaceous residue off the cata lyst as it comes from the cracking operation.

These two units are typical of the Horton ste plate structures we build for the petroleum in dustry. In addition we build absorber tower propanizers, scrubbers, or whatever processin units your refinery requires.

Write our nearest office for information. Ther is no obligation on your part.

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Horton Floating Roofs to stop evaporation, cut down corrosion and reduce fire hazard on working storage tanks.

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COMBINED EDITION

• Drilling and Producing • Refining and Gas Processing • Oil and Gas Pipelining

APRIL, 1952 • VOLUME XXIV • NUMBER 4

GENERAL

East Side of the Julesburg Basin A-49
R. W. McCanne
Yenter Pool A-61
W. K. Arbuckle
South Dakota A-71
John Paul Gries
Oil and Gas in Alabama A-81
Walter B. Jones

Features

Course of Oil A-4
With the Editors A-8
Highlights in Oildom A-10
Petrolic Personalities A-12
Dick Sneddon
Meetings A-14
Petroleum Profile A-88
W. G. Skelly
General News E-2
General Personals E-12
The Petroleum Engineer's Continuous Tables E-19
(Installment No. 177)
Laugh with Barney E-26
Books E-28
Oil and Gas Trade News E-30
Trade Personals E-38
New Machinery and Supplies E-53
Trade Literature E-57

DRILLING AND PRODUCING

Modern Methods Revive McKittrick Lease B-7
William T. Rintoul
Some Considerations in Selection of Sucker Rods B-12
Kenneth N. Mills
Natural Organic Colloids of Iranian Origin as Mud Treating Agents B-45
George Tchillingarian and Carrol M. Beeson
Installation of Pumping Unit B-54
Jack L. Coulson
Petroleum Exploration and Development in France B-58
Dr. J. Dupouy-Camet
Spraberry Drilling and Completion Methods B-72
John L. Cox
Oil Reserves Menaced by Mass Salvaging B-78
F. R. Cozzens
Geophysical Exploration Comes of Age B-84
Sigmund Hammer
Current Mud Programs in the Uintah Basin B-89
R. D. Blaicher and William J. Knight
The Lee Field, Morgan County, Colorado B-92
C. R. Neal
Cost Trends in Contract Drilling B-95
John McEwen
Merino Field, Colorado B-99
API Sets U. S. Oil Reserves Up Five Billion Barrels B-101
Black Light Aids Oil Exploration B-103

Features

Presenting B-3
Producing News B-104
What's Doing in Drilling B-108
Exploration Activities B-112
Running Tour With Men in the Industry B-118

REFINING AND GAS PROCESSING

More Catalysis—Refining's Watchword C-3
Arch L. Foster
Heat Transfer in Spiral Coils C-7
M. A. Noble, J. S. Kamlani, J. J. McKetta, Jr.
Insulation Methods for Air-Lift TCC Unit C-22
S. E. Swenson
Petrochemicals from Water Gas—Part 1 ..... C-28
Peter W. Sherwood
Salvage Cleaning C-38
Vincent E. Bowes
Cooling Tower Maintenance C-44
Howard E. Degler
Relationship of Furnace Volume and Heat Release C-51
D. F. Gerstenberger
Hydrous Calcium Silicate Heat Insulation C-55
E. C. Shuman
New Analytical Methods C-63
Polarographic Determination of Zinc in Oils
How to Service Coolant Condensers
Heater for Aniline Point Apparatus
Processing Sulfur Bearing Gases C-68
C. L. Blohm
Insulating Cement—A Versatile Heat Saver C-75
TC Reforming Process Regenerates Catalyst C-79
Michigan Refinery Yields 35-40% Aromatics C-83
J. C. Albright

Plant Aids

Suspended Cellar Scaffold C-26
Permanent Scaffold Bracket and Boilers C-76
Automatic Water Treatment Feeder C-81
Micarta Piston Rings for Pumps C-81
Elimination of Excess Pump Packing C-81
Tar Heater C-81
Crank Bearing Clearance Gage Support Bracket C-82
Stainless-Steel Paint C-82
Circular-Scale Design and Full-View Dial C-82
Side Boom Used for Loading Pipe C-89

Features

Refining and Gas Processing News C-84
Refining and Gas Processing Personals C-90

OIL AND GAS PIPELINING

Cushing-Chicago Line Under Construction D-3
Frank H. Love
Protective Casings for Pipe Lines D-7
M. G. Spangler
PAD's Survey of Transportation Needs D-24
Use of Aluminum Pipe in Oil Country Applications D-28
William B. Moore, Jr.
The Wear-Compensating Pipe Line Scraper D-35
B. Ver Nooy

Features

Pictorial D-44
Oil and Gas Pipelining News D-47
Pipe Line Personals D-57
Pipe Line Projects D-60
With the Pipe Line Contractors D-66

The PETROLEUM ENGINEER Publishing Company, Irwin-Keasler Building, DALLAS 1, TEXAS. W. L. LOVE, *President*; W. T. BRYAN, *General Manager and Treasurer*. **Editorial Staff**—K. C. SCLATER, *Vice President and Editor-in-Chief*; ERNESTINE ADAMS, *Managing Editor*; JACK MENNEER, *Editor, Drilling and Producing*; ARCH L. FOSTER, *Editor, Refining and Gas Processing*; FRANK H. LOVE, *Editor, Oil and Gas Pipelining*; RICHARD SNEDDON, *Editor Pacific Coast*, 1106 B North Louise Street, Glendale 7, California. Phone, Chapman 5-1951; MARY MORRIS LYMAN, *Assistant Editor*; HENRIETTA O'BANNON, *Art Editor*. **Advertising Staff**—T. J. CROWLEY, *Vice President and Advertising Manager*; New York—JOE B. WOODS, 52 Vanderbilt Avenue, New York 17, New York. Phone MUrray Hill 4-1880; Chicago—E. V. PERKINS, 53 West Jackson Blvd., Chicago 4, Illinois. Phone HArrison 7-883; Los Angeles—RICHARD P. McKEY, Bendix Bldg., 1206 South Maple, Los Angeles 15, California. Phone PRospect 3919. **Promotion**—ABBOTT SPARKS, *Manager*; ROYAL COURTNEY, *Assistant Circulation Manager*. *Copyright 1952 by The Petroleum Engineer Publishing Company.*
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DOMESTIC CRUDE CAPACITY LAGS

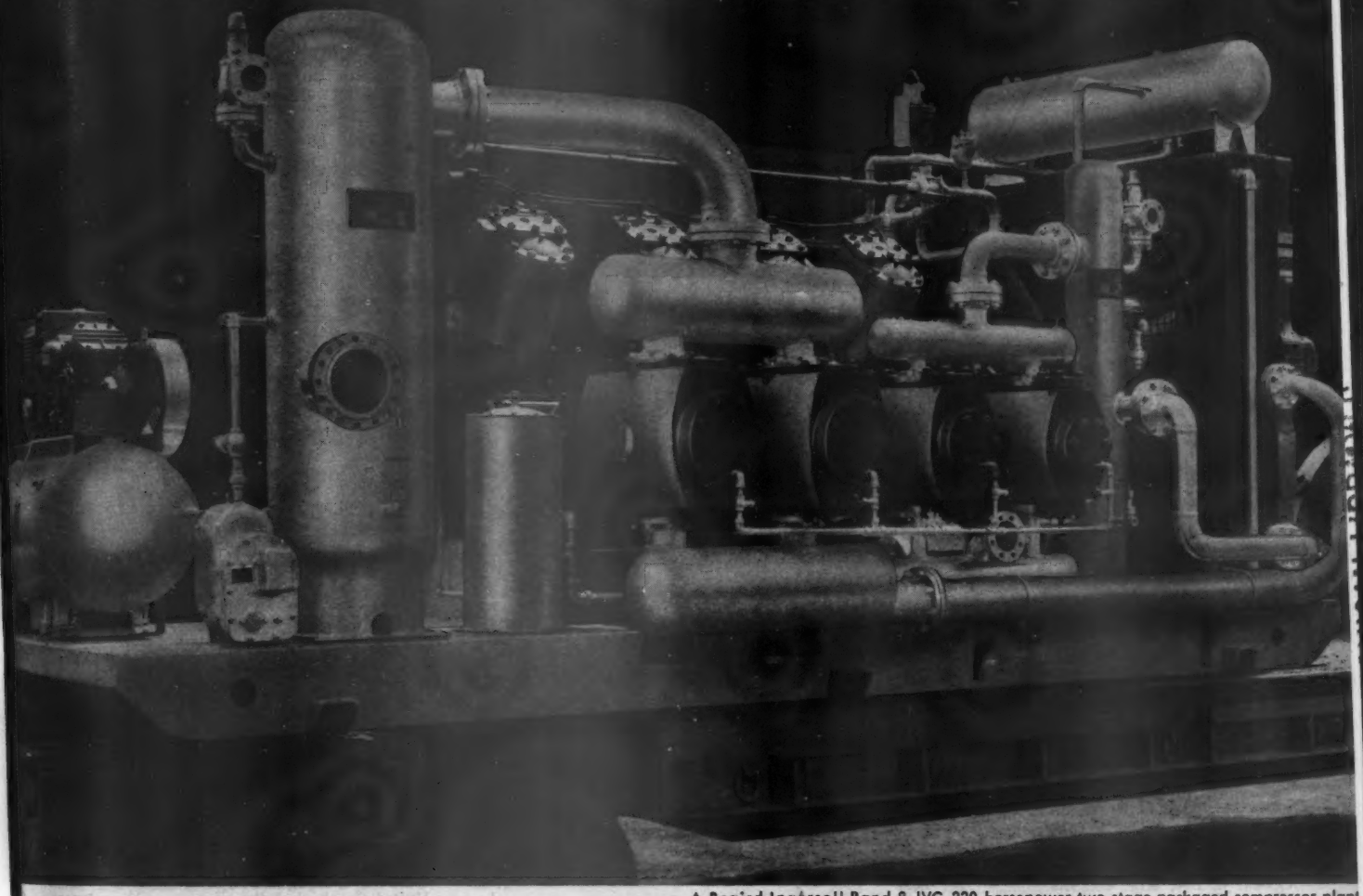
IN view of the fact that a national emergency exists in which petroleum is so vital, available domestic oil capacity is still far from adequate. Our domestic demand for oil in 1951 was 7,044,000 bbl a day. What about our capacity? Available domestic crude capacity is estimated to be about 7,500,000 bbl a day. In other words, our excess capacity of available domestic crude is not much more than 500,000 bbl a day. Obviously, our available domestic crude capacity is tragically lacking to oil a full-scale war. It is well to remember this when figures are quoted showing that the new oil reserves discovered in 1951 were the greatest of any year recorded. Despite this record, the discovery per well was lower than in any previous year. This means that more wells must be drilled yearly to maintain an adequate available domestic oil reserve. Increased expenditures will be necessary. It cannot be assumed that available domestic petroleum reserves are in step with the national emergency program, for we cannot afford to depend upon foreign imports should war break out.

We are not yet self-sufficient in available domestic oil reserves for civilian needs and still have sufficient reserve capacity to take care of any emergency. The need for developing available new domestic reserves is urgent. According to Cecil L. Burill, Director of the Program Division of the PAD "from a security point of view, we have consumed practically all of our reserve capacity and are in a much worse position today to fight a major war than we were in 1940, when we had 25 per cent spare refining and crude oil capacity. We desperately need to build spare capacity in producing, refining, and attendant facilities. At present we have no flexibility with which to meet even the possible peace-time emergencies, let alone those demands that would result from a full-scale war." This statement was made in January of this year and is one for the industry to ponder.

The oil industry is expected by PAD to drill 50,000 wells this year and 55,000 wells in 1953. Future costs of exploration will be higher than they are today. From December, 1947, to November, 1951, wages and salaries in petroleum production have increased "38 per cent; cost of equipping wells, 31 per cent; prices of equipment and supplies, 26 per cent; cost of services, 19 per cent; and composite price of finished yield, 31 per cent." It is evident, then, that "The industry must have adequate materials, sufficient man power, and the freedom to make competitive adjustments through which the funds required for expansion are generated." Even though it gets the necessary materials and every incentive to expand its operations, the industry is confronted with a formidable task.

Complete Packaging Saves You Money

ON YOUR BEAIRD-INGERSOLL-RAND PACKAGED COMPRESSOR PLANT



A Beaird-Ingersoll-Rand 8 JVG 220 horsepower two-stage packaged compressor plant
Other models available from 110 to 550 horsepower.

Y*OU RECEIVE A COMPLETE PLANT,* including every component, connection and control you would expect in a large stationary compressor plant. The Beaird-Ingersoll-Rand packaged compressor plant is designed specifically to meet your operating requirements . . . gas engineered as well as mechanically engineered . . . completely assembled . . . and mounted on a rugged steel base. It may be transported directly to your location as a unit, requiring only a minimum amount of field installation. If your field conditions should change, the plant can be moved intact to a new location at a big saving in re-installation costs.

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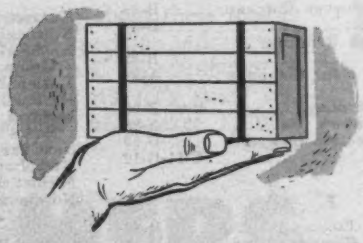
Let us show you how you will save by installing a Beaird-Ingersoll-Rand packaged compressor plant.

For use in: gas lift, field gas gathering, flare gas collection, repressuring.



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MACHINING
FABRICATING
STEEL WAREHOUSE

ADVERTISERS' INDEX

A

Acme Fishing Tool Co. B-81
Aetna Ball and Roller Bearing Co. B-87
Ajax Iron Works B-24
Aldrich Pump Company, The A-41
Allis-Chalmers A-7
Allis-Chalmers Tractor Division D-21
Amercoat Corporation A-44
American Blower Corporation E-28
American Car & Foundry Company A-47
American Chain and Cable Co., Inc. A-14
American Coating Supply Company D-69
American Foreign Insurance Association A-39
American Iron & Machine Works Co. B-15
American-LaFrance-Foamite Corp. E-27
American Locomotive Company D-23, D-53
American Manufacturing Company of Texas A-2
American Sand-Banum Co., Inc. E-46
American Steel & Wire Division A-27
American Telephone & Telegraph Co. D-34
Armstrong Bros. Tool Co. E-42
Attapulgus Clay Company C-67

B

B and W Incorporated B-40
Baash-Ross Tool Company B-73
Babcock & Wilcox Company A-16a
Baker Oil Tools, Inc. B-4-B-5
Baroid Sales Division, National Lead Company B-29, B-117
Beaird, J. B., Company, Inc. A-5, C-27
Beaver Pipe Tools E-19
Bechtel Corporation D-25
Bethlehem Steel Company B-22, B-80
Black, Sivalls & Bryson, Inc. A-74-A-75
Blaw-Knox Company A-22, E-16, E-49
Boston Woven Hose & Rubber Company A-28
Bowen, S. R., Company B-76
Briggs & Stratton Corporation B-50
Brown Fintube Co., The A-13
Bucyrus-Erie Hydrocrane Division A-18
Byron Jackson Co. B-65, C-21

C

Cable & Staples B-121
Cameron Iron Works, Inc. Front Cover, C-2
Cardwell Mfg. Co., Inc. B-74-B-75
Cast Iron Pipe Research Association C-89
Caterpillar Tractor Co. B-37
Chapman Valve Mfg. Co., The A-24
Chicago Bridge & Iron Company Inside Front Cover
Chrysler Corporation A-43
Clark Bros. Co., Inc. E-1
Classified Advertisements E-11
Cleaner Pipelines Co. D-26
Colorado Fuel & Iron Corporation, Wickwire Spencer Steel Division A-42
Columbia-Geneva Steel Division A-27
Continental Supply Company B-56-B-57, C-23
Cook, C. Lee, Mfg. Co., Inc. A-9
Cooper-Bessemer Corporation A-64-A-65
Core Laboratories, Inc. B-115
Crane Co. E-18
Cummins Engine Company, Inc. E-24

D

Dean Brothers Pumps, Inc. E-47
Dean Hill Pump Company E-31
Dearborn Chemical Company D-61
Detroit Diesel Engine Division, General Motors Corporation A-87
Dow Chemical Company, The D-11
Dowell Incorporated A-48
Dresser Industries, Inc. B-11, B-67, E-1
Drilling & Service B-17
DuPont, E. I., de Nemours & Co. C-29-C-30
Durametallic Corporation E-43

E

Eastman Oil Well Survey Company B-33
Elder & McNulty D-48
Eldorado Mining and Refining (1944) Limited B-82
Electric Machinery Mfg. Company A-36
Emsco Derrick & Equipment Company B-97-B-98
Engineers & Fabricators, Inc. A-29
Engineering Construction Company D-59
Ethyl Corporation C-11-C-12

F

Fairbanks-Morse & Co. B-32
Farrel-Birmingham Company, Inc. D-41
First National Bank in Dallas E-22
Fluid Packed Pump Company B-61-B-62
Fluor Corporation, Ltd., The A-16b, A-16f
Foxboro Company, The C-36-C-37
Fram Corporation D-56
France Packing Company A-11

G

Gardner-Denver Company B-38
Gaso Pump & Burner Mfg. Co. D-1
General Electric Company D-37
Geolograph Company B-52
Geophysical Survey Syndicate B-105
Glass Fibers, Inc. A-16c
Grant Oil Tool Company B-66
Great Lakes Carbon Corporation B-27
Grove Regulator Company B-25
Guiberson Corporation B-47
Gulf Oil Corporation A-26

H

H & M Pipe Beveling Machine Company D-65
Haering, D. W., & Co., Inc. E-14
Halliburton Oil Well Cementing Co. Back Cover, B-34
Harrisburg Steel Corporation E-59
Hercules Tool Company B-105
Hilliard Corporation, The A-46
Houston Contracting Company D-26
Hudson Engineering Corporation C-15
Hughes Tool Company B-1
Humble Oil & Refining Company A-32
Hyatt Bearings Division, General Motors Corporation B-85

I

Ingersoll-Rand C-88
International Harvester Company E-20
Iverson Supply Company B-83

J

Jensen Brothers Mfg. Co., Inc. B-100
Johns-Manville D-63
Johnston Pump Company E-5
Johnston Testers, Inc. B-28

K

Kellogg, M. W., Company, The E-17
Kerotest Manufacturing Company C-73
Kinney, Inc. B-86
Knudsen, Vic, Rigging Co. D-67
Koch Engineering Company, Inc. C-80
Koehring Company D-15, E-7
Koppers Company, Inc. A-35, D-27

L

Ladish Company A-79
Lane-Wells Company Inside Back Cover, B-2, B-20, B-69, E-26
Larkin Packer Co., Inc. B-107
Layne & Bowler, Inc. E-36
Ledeen Mfg. Co. E-40
Levingston Shipbuilding Co. B-122
Lincoln Electric Company, The A-67
Link-Belt Company B-51
Link-Belt Speeder Corporation D-29
Longhorn Industries, Inc. D-49
Lucey Export Corporation B-44
Lufkin Foundry & Machine Co. B-19
Lufkin Rule Co., The A-16
Lummus Company, The C-32
Lunkenheimer Co., The A-33

Mc

McCullough Tool Company B-119
McNamar Boiler & Tank Co. C-74

M

Magnet Cove Barium Corporation B-11
Manning, Maxwell & Moore, Inc. C-65
Marley Company, Inc., The A-45
Martin, Chas., & Company C-43
Martin, John N., Manufacturer B-52
Martin-Decker Corporation B-42
Mason-Neilan Regulator Company C-77
Master Tank & Welding D-9
Mayo Hotel E-43
Mercoid Corporation E-4
Miller Sand Pump Co. B-81
Minneapolis-Honeywell Regulator Co. D-33
Mission Manufacturing Company B-79
Moore, Lee C., Corporation B-21
Murphy Diesel Company B-94

N

Natasco Company, The C-35
National Airoil Burner Co., Inc. C-86
National Carbon Company, a Division of Union Carbide & Carbon Corp. C-18-C-19
National Supply Company, The A-57-A-60
National Tank Company E-60
Natural Gasoline Supply Men's Association C-61
New York Belting & Packing Co. B-56, B-57
Nicholson, W. H., & Co. E-54
Nicolet Industries, Inc. D-54
Nordberg Mfg. Co. D-18

O

Oakite Products, Inc. E-36
Ohio Injector Company, The A-19
Oil Center Tool Company B-41
Oil Well Supply Division A-1
Onan, D. W., & Sons, Inc. D-12
Orbit Valve Company C-45
Owens-Illinois Glass Company C-41

P

Pacific Coast Borax Co. E-55
Parkersburg Rig & Reel Co. B-31
Parsons Co. D-15
Peerless Manufacturing Co. A-25
Pelican Well Tool & Supply Co. D-40
Pelton Water Wheel Company B-71
Penberthy Injector Company E-39
Perrault Brothers E-42
Petro-Chem Development Co., Inc. A-77
Petroleum Electric Power Association E-13
Petroleum Rectifying Company C-25
Philco Corporation D-13
Phillips Petroleum Company, Perco Division C-9
Pittsburgh Coke & Chemical Co. D-55
Plastex Pipe and Extrusion Company B-77
Powell, Wm., Company C-49
Pyle-National Company, The C-87

R

Radio Corporation of America A-85
Reading, Pratt & Cady Valve Division A-14
Rector Well Equipment Company, Inc. B-23
Reda Pump Company B-68
Reed Roller Bit Company B-6
Refinery Supply Company A-34
Regan Forge & Engineering Co. B-26
Republic National Bank of Dallas E-3
Republic Steel Corporation B-39, D-17
Rice Hotel E-46
Ridge Tool Company, The E-6
Rockford Clutch Division B-88
Rockwell Manufacturing Company A-69-A-70, C-47
Rolo Manufacturing Company B-121
Roper, Geo. D., Corp. E-29
Royston Laboratories, Inc. D-70
Rust-Oleum Corporation A-37

S

Schlumberger Well Surveying Corporation B-43
Security Engineering Co., Inc. B-67
Shaffer Tool Works B-59
Shell Oil Company B-91
Skinner, M. B., Company C-76, D-40
Smith, A. O., Corporation C-53, E-33
Southern Mill & Manufacturing Co. A-80
Standard Oil Company of California A-40
Superior Iron Works & Supply Co., Inc. E-15

T

Tennessee Coal & Iron Division A-27
Thew Shovel Co., The D-31
Thompson Tool Co. E-56
Thornhill-Craver Co. D-2
Trane Company A-63
Tretolite Company C-39
Trojan Construction Co., Inc. D-62
Tube Turns, Inc. E-9-E-10

U

Union Carbide & Carbon Corp., National Carbon Company C-18-C-19
Unit Rig & Equipment Co. B-35
United Geophysical Company B-113
United States Steel Corporation A-1, A-27, B-109
United States Steel Export Co. A-27
United Supply and Manufacturing Company B-36
Universal Atlas Cement Company B-109
Universal Oil Products Company C-58-C-59

V

Victaulic Company of America B-70
Visco Products Company, Inc. E-50
Vogt, Henry, Machine Co. C-17
Voss, J. H. H., Inc. D-38

W

W-K-M Company D-68
Watson-Stillman A-83
Waukesha Motor Company A-23
Waukesha Sales & Service, Inc. B-53
Welex Jet Services, Inc. B-13
Well Equipment Mfg. Corp. C-85
Western Supply Company D-43
Westinghouse Electric Corporation A-20-A-21
Weston Electric Instrument Corp. C-20
Wheeling Machine Products Company A-46
Wickes Boiler Co., The A-30
Wickwire Spencer Steel Division, Colorado Fuel & Iron Corp. A-42
Williamson, T. D., Inc. D-42
Wilson Foundry & Machine Co. B-30
Wilson Manufacturing Co., Inc. B-111
Winslow Engineering Company A-17
Wisconsin Motor Corporation E-40
Worthington Pump & Machinery Corp. A-38
Wyatt Metal & Boiler Works A-16d

Y

York, Otto H., Inc. C-72
Young Radiator Company A-15
Youngstown Sheet and Tube Company A-31

Z

Zachry, H. B., Co. D-52
Zink, John, Company C-1

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...PLUS MINIMUM MAINTENANCE

1250-hp, 3575-rpm motor driving compressor.

ALLIS-CHALMERS Tube-Type TEFC MOTORS

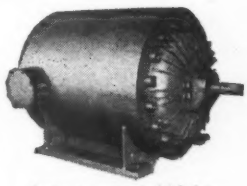
A few years ago, explosion-proof motors were limited to small sizes — because there was no practical way to cool large totally-enclosed fan-cooled motors. Allis-Chalmers ended that limitation with the introduction of *tube-type* air-to-air heat exchanger construction in 1946.

Tube-type construction makes both large sizes and minimum maintenance possible because it provides:

1. **Full internal air circulation** plus *circumferential tube distribution* . . . to assure efficient, even cooling of motor.
2. **Complete enclosure** . . . to protect stator core and other electrical parts from both dirt and corrosion.
3. **Self-cleaning action** . . . result of generous flow of outside air through smooth, straight heat exchanger tubes.

RATINGS AVAILABLE

Both standard and explosion-proof TEFC motors are built with *tube-type* construction in ratings from 40 hp at 600 rpm to several thousand horsepower. Ratings up to 800 hp at 3600 rpm are available with Underwriters' labels.



Ratings up to 800 hp, 3600 rpm.

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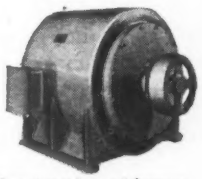
In sizes from 250 to 2500 hp alone, purchases of these *tube-type* motors total more than 215,000 hp. For more information about these motors that have been proved in operation indoors and out, call in your nearby A-C representative or write for Bulletins 51B7149 *(it's new)* and 05B7150. Allis-Chalmers, Milwaukee 1, Wis.

A-3669



Construction of larger ratings.

ALLIS-CHALMERS

With The EDITORS . . . . . .

Small Refiners Running Wild!

Small refiners are coming into their own, according to latest report from Bruce Brown, PAD. That body recommends additional capacity for rapid amortization which when completed will raise the small refiners' rated output by 29 per cent of their present capacity for crude, and will boost their catalytic cracking capacity by four times. Small refiners are classed arbitrarily as those having less than 20,000 bbl per day crude capacity. Intermediate refiners, having from 20,000 to 49,000 bbl per day ratings, will add more than 50 per cent to their catalytic cracking capacity, and one-fourth to their crude-processing capacity. Similarly, large refiners, 50,000 bbl per day and up, will increase crude capacity by 15 per cent, cat cracking capacity by 41 per cent, Brown says.

This small refiner group includes slightly less than 10 per cent of the total U. S. rated crude capacity, which will be raised to nearly 11 per cent; catalytic cracking, now less than 2 per cent, will be raised to more than three times that or nearly 6 per cent. Following discontinuance of Cerificates of Necessity last year, PAD has revised the expansion program, to step up the refinery expansion rate to 475,000 bbl daily per year, a plan, if approved by DPA, that will call for more Certificates.—A.L.F.

Cat Cracking and 'Branded' Gasoline in England

The installation of catalytic cracking units in Britain appears to be hastening the time when England will again permit the marketing of branded gasolines, reports from there say. To facilitate transport and supply of motor fuels during the late war the British government eliminated branding in selling fuel, and since then all petrol has been supplied without identifying name or brand. That this is distasteful to oil companies is obvious.

Word comes that the restoration of brand names is expected not later than the summer of 1952. With it will come the matter of refiners trying to obtain as many exclusive stations as possible, called "tied-house" stations. One major push to hurry the return of brands is of course that of refiners wishing to take advantage of their new catalytic cracking facilities, and to capitalize on the improved qualities of their own motor fuels. This is obviously true of such companies as Esso, Jersey Standard subsidiary, with a newly operating fluid unit at the Fawley plant; and of Shell, with a unit in operation at Stanlow. Additionally, Anglo-Iranian at Grangemouth and at Llandarcy will have units operating before year's end, another in Kent by mid-1953. Vacuum is building one at Coryton, to be operating early in 1953.

Some other companies do not have prospects for adding catalytic gasoline to their products, thus are reluctant to push resumption of brand names since they cannot boast of their new and improved fuel, and thus these organizations will be content to delay branding their pumps and products.

The large increase in British refining capacity accentuates the competition for the apparently slowly rising volume of motor fuel consumed there, and observers believe this augurs for better improved service in British service stations, never very good at any time by comparison with U. S. service station handling. Significantly enough, *The Petroleum Times* (London) in a recent editorial comment states "The petroleum companies are entirely justified in trying to obtain as many 'tied' outlets for motor spirit as possible," adding that this aspect of the industry will prevent monopoly. American courts and lawmakers might do well to consider this idea.—A.L.F.

Natural Gas Reserves Show Gain

The latest report on natural gas reserves made jointly by the American Gas Association and the American Petroleum Institute lends further credence to those who all along have maintained that the supply is in no danger of being depleted despite the fact that within recent years consumption has assumed greatly increased proportions. Proved recoverable reserves at the beginning of this year totaled 193.8 trillion cubic feet, an increase of 8.2 trillion cubic feet over estimated reserves of the previous year, which were 185.6 trillion cubic feet.

Thus, reserves attained a new record high level, scoring the second highest increase since the AGA-API estimates were instituted. It is notable, also, that the increase was registered over an all-time high production and use of natural gas during 1951 of 8 trillion cubic feet. In 1950 the production of natural gas was 6.89 trillion cubic feet.

Of further interest, the AGA-API committee on natural gas reserves estimated proved recoverable reserves of natural gas liquids at the beginning of the year also had risen to a record level, totaling 4.72 billion barrels. This compares with a previous high of 4.27 billion barrels at the same time a year ago, and the increase was made despite a record production of 267 million barrels of natural gas liquids last year.

The increase of 13 trillion cubic feet in proved natural gas reserves through extensions and revisions of previous estimates for existing fields reflects the results of improved drilling methods and increased exploration, the report states. Discoveries of new natural gas fields and new pools in old fields also accounted for an important increase of 3 trillion cubic feet in proved recoverable reserves.

Estimated reserves of natural gas in underground storage at the beginning of 1952 were 132.8 billion cubic feet greater than for the year before.

New pipe lines serving metropolitan New York, New England, and increased residential and industrial use in other areas, brought natural gas production to an all-time high level. Despite this fact, however, proved reserves of natural gas and natural gas liquids made substantial gains.—F. H. L.

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HIGHLIGHTS IN OILDOM

TIDELANDS DEBATE WATCHED

While the Senate is wrangling over state vs Federal ownership of submerged offshore oil lands, holders of inland underground mineral rights are beginning to wonder if their own rights will someday be affected by whatever decision is finally reached.

Senator Cain, Republican, Washington, warned Senate of expanding Federal claims, adding that the Secretary of Interior Oscar Chapman had requested the state of Washington to cease issuing oil and gas drilling permits off its shores. He urged senators to "bear this warning fact in mind. Every state in the union is equally subject to the strange, dangerous doctrine 'paramount power' which the federal government believes it has," Cain added.

TWO IOCC OBSERVERS SELECTED

Governor Sid McMath of Arkansas, chairman of the Interstate Oil Compact Commission, has announced that Venezuela will become an official observer, Interstate Oil Compact Commission.

Venezuela is the second foreign government to affiliate with the Compact Commission, the first being the Province of Alberta, Canada, which came into the Compact as observer during 1947.

Also recently announced is Province of Saskatchewan's acceptance of the invitation to become an official observer in the IOCC. It will have all rights of membership except that of voting and holding office. J. H. Brockelbank, minister of natural resources, accepted the invitation.

OILMEN EVADING TAXES: HUMPHREY

The Public Affairs Institute has distributed a booklet in which Senator Hubert Humphrey has charged that oil companies are evading $750,000,000 a year in taxes through tax law loopholes. The senator claimed that 12 millionaires owning oil wells paid an average income tax of only 22½ per cent on their income. Russell B. Brown, general counsel of IPAA, has replied, saying the senator "has been badly advised."

MORE ENGINEERS NEEDED

For the next five to seven years, industry's requirements for engineers and technically trained personnel will so far exceed the available supply that a complete re-evaluation must be made of the work in which these specialists are currently engaged. This was the conclusion reached by a group of educators and engineering executives from the metropolitan area at a recent conference sponsored jointly by the New York University College of Engineering and the magazine, *Product Engineering*. It was further agreed that greater use probably will be made of technical assistants and students.

SCRAP IRON ANSWERS

Two questions and answers published by the *Scrap Roundup* will prove of interest to many readers:

Q. How much steel has been lost because of the scrap shortage?

A. It's not feasible to claim a production loss up to now. Some furnaces have been down a few days, but the tonnage lost is small. One of the most serious production problems is shortage of No. 1 heavy melting scrap. Steel producers need more heavy scrap, but they are also eager to get practically any kind of industrial scrap today—to keep the furnaces operating.

Q. Are the scrap dealers holding a lot of scrap, hoping for higher prices?

A. The dealers are not holding back scrap. A full yard is the best assurance that scrap is on the way to the furnaces — after it is sorted, prepared, and shipped.

NAVY ASKS FOR MORE OIL

The Navy department has informed 28 oil firms that its oil needs are not being met, and has implied that drastic measures may have to be taken. The Armed Services Petroleum Purchasing Agency asked for offers of 5,300,000 bbl of Navy special fuel oil for delivery by the end of June. The Navy reported that since November it has been trying to line up 9,500,000 bbl of fuel oil for the Navy's use in the first half of this year.

OIL INVESTS $500 IN EACH NEW CAR

For every additional car that goes on the road, the oil industry puts up $500 as investment in new facilities, Dwight F. Benton, Standard Oil Company (Indiana), told South Side automobile dealers at the Chicago Automobile Show.

"That's what it takes to provide the producing, refining, and distributing equipment to keep one additional car rolling. It's a staggering total," he declared, with the number of cars in operation up about 2,400,000 last year.

"The cost of these new facilities is met by the oil companies themselves," he said.

"We must please the public, not the bureaucrats," he added.

AVAILABILITY OF OIL RISES

Available supplies of oil and gas in the U. S. are expected to rise to 8,838,000 daily, the National Petroleum Administration for Defense has predicted. The National Petroleum Council, at the request of the Interior Department, made public a report on petroleum productive capacity. Availability in all foreign areas outside those dominated by Russia was estimated within a range of 6,669,000 to 7,437,000 bbl daily by 1955, compared with an availability range of 4,703,000 daily in January, 1951.

OIL MEN'S WAGE DISPUTE GOES TO WSB

The dispute over oil workers' salaries has been referred to the War Stabilization Board for settlement.

Many of the companies reportedly resent WSB's part in settling the question. Socony-Vacuum released the text of a letter signed by William Montgomery, director of industrial relations. He said, "No basis exists today in our opinion, for placing before a *national* wage panel the questions that your Board is attempting to consider and solve."

The Department has released statistics showing workers in the petroleum industry are among the highest paid in all industry, ranking at the top or close to the top.

RUSSIA TAKES AUSTRIAN OIL

Russia is taking 7,000,000 bbl of oil yearly from Austria without paying one cent to the Austrian government, Senator Allen J. Ellender disclosed recently. Senator Ellender, who has just returned from Austria, reported that the United States is pumping $100,000,000 yearly into that country in order to keep it alive. He said the Russians are funnelling the oil from Austria to Moscow.

CANADIAN OIL OUTPUT HITS PEAK

The Department of External Affairs in Ottawa, Canada, has reported that production of crude petroleum and natural gasoline in that country reached a new peak in 1951. Output aggregated 48,123,370 bbl, compared with 2,093,724 bbl in 1950. Gains were due almost entirely to expansion from Alberta.

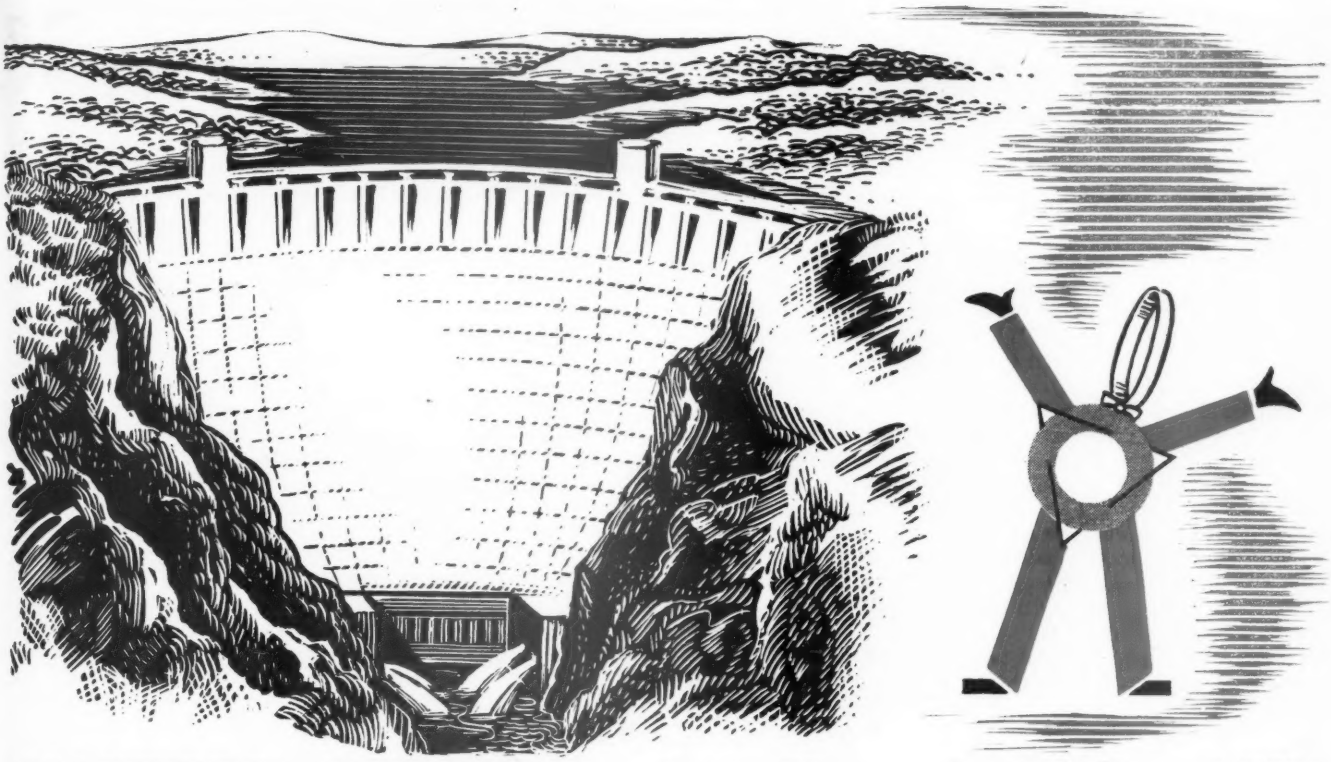
DEMAND TO DECREASE: WILSON

The oil industry has just completed a period of unparalleled expansion, in which both physical and financial resources were strained to meet a record-breaking growth in demand for virtually all products, Dr. Robert E. Wilson, chairman of the board of Standard Oil Company (Indiana), has declared.

Comparing 1951 with 1940, the domestic demand for oil products was up 94 per cent, he said. Comparing individual products for the 11-year period, gasoline was up 86 per cent, diesel fuels up 419 per cent, other distillate fuels up 136 per cent, residual fuels up 66 per cent, natural gas up 154 per cent, chemicals from petroleum up 1700 per cent, liquefied petroleum gas up over 13,000 per cent.

Dr. Wilson said the demand curve is expected to flatten off due to:

1. Increasing use of natural gas.
2. Fewer coal furnaces to convert.
3. Most large farms are already well mechanized.
4. Railroad dieselization is well along.
5. Fewer new cars in the next two years.



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INDUSTRIAL PACKINGS FOR MORE THAN 50 YEARS

PETROLIC PERSONALITIES

DICK SNEDDON

HE NEVER GOES TO BED

In Lomas, one of the suburban towns near Mexico City, there is an equipment importing concern known as Pazo y Cia Sociedad Anonyma. What that means we haven't the slightest notion, but we do know that the organization is presided over by one of our old friends, Don Carlos Rudolfo Schneider, erstwhile native of Galveston, Texas, and one of the grestest boulevardiers of all time. Charlie, as he was known before he began to effect sombreros, serapes, huarachas, and such things has had an interesting career—in fact, he is still having it. In the 20 years more or less that we have been acquainted with him, we doubt if he has ever gone to bed. Last thing in the wee sma hours, through almost closed eyes, we see the guy hopping about as lively as a young grasshopper, and no matter how early we rise next morning, there he is, looking as dapper and relaxed as ever.

Charlie used to be assistant to Court Decius, the Tide Water Associated Oil Company vice president in charge of exploration. He resigned his job in 1947, went down to Mexico, and now spends most of his time at the Hipodromo de las Americas laying pesos on horses' noses in an effort to get nothing for something. His son-in-law is Ingeniero Adolfo Orive Alba, minister of hydraulics in the Mexican government, so Charlie is right at home in the land immediately south of the border, and you can tell by looking at him that he loves it.

MACADAMIAN NUT TREE REMAINS OBDURATE

All of which further reminds us that Bill Heater, another Baroidian, is still to no avail trying to coax his Macadamian nut tree to do something or get off the nest. It seems a shame that Bill, who is really a kindly soul, should have to purchase all the Macadamian nuts he needs while this oriental shrub continues to sulk in barren obstinacy. Bill Beck, the Socony purchasing biggie, and his lovely helpmeet, Marge, were recent vacationers, in Bermuda. On their way down they ran into such a terrific hurricane that Bill almost bit the end off his cigar. Later, however, things really smoothed down and they had a very enjoyable time.

Before leaving New York, Ox Morgan showed pictures of the Stanford-Illinois Rose Bowl game to Jim Woods, Bill Clark, Phil Hauck, and Frank Shlemmer of The Texas Company; Kenny Ross, the new Baash-Ross export manager; and Don Brown and some of his friends from Aramco. The weeping and lamentation that took place during the filming of this sad event has been likened to the wailing of the banshees but we understand that the banshees object to the comparison and have lodged a formal protest with Washington.

OF ELECTIONS, SPEAKER, AND DIVOTS

Bill Wilson, scion of the House of the Yellow Tiger, has been unanimously elected prexy of the Los Angeles chapter Nomads in place of Earl Rees who was transferred to New York to take Ox Morgan's place for Byron-Jackson as export manager. Bill should do a good job. He is a nice appearing young chap with a pleasing smile, good platform deportment, and a generous grist of common sense. Like George Trembley and Bill Farrand, however, he is addicted to the wearing of raucous sports shirts and his wardrobe is a positive menace to weak eyes.

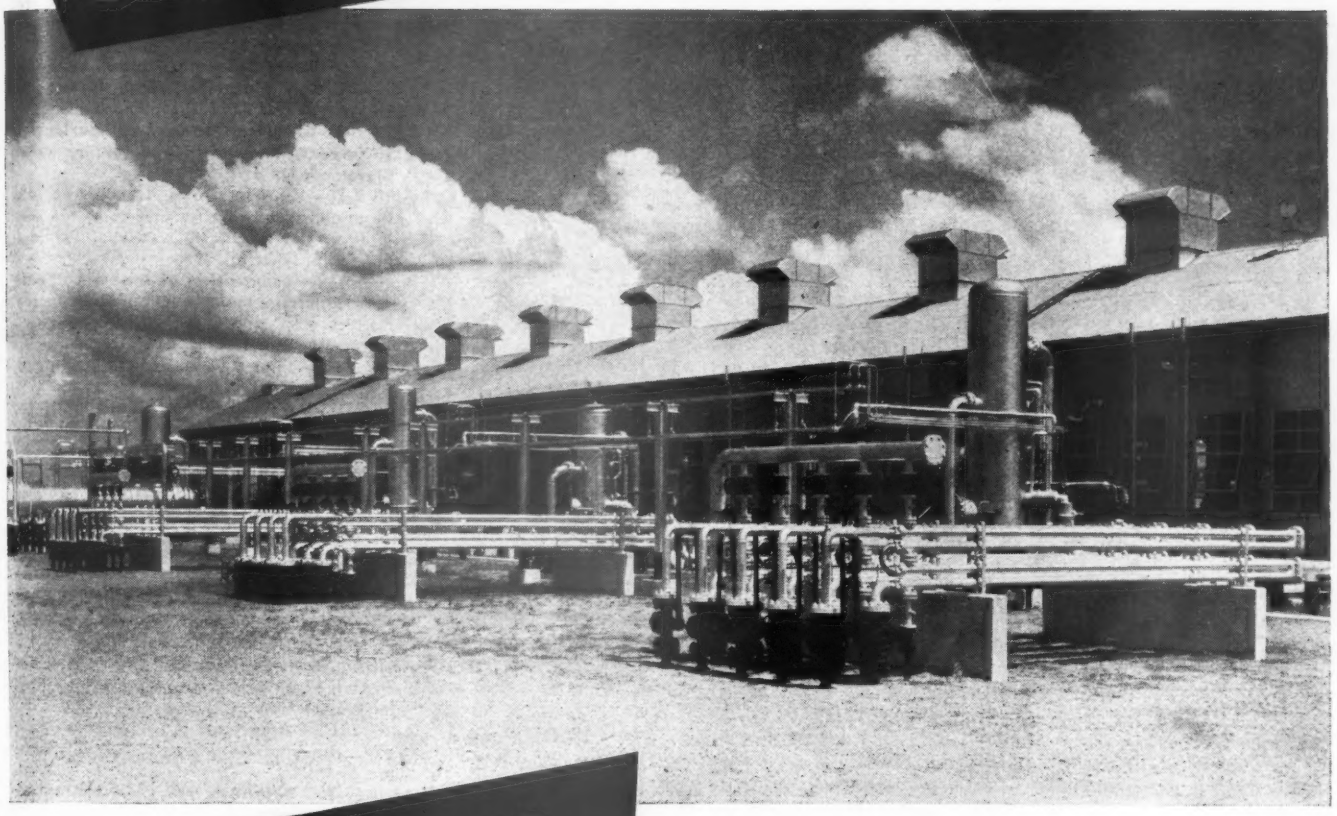
Incidentally, Bill Farrand, late of The Texas Company, New York, now temporarily of PAD, Washington, D. C., was the principal speaker at the March meeting of the Los Angeles Nomads and comported himself well, giving the boys a really interesting talk on allocations and stuff. During the short time that Bill was out on the west coast, it is estimated that the production of divots increased by some 43.8 per cent, a great tribute to a great guy, as they say at the movie dinners.

MUCH ADO ABOUT SMITH

Whom should we meet at the ritzy Lakeside Country Club over Hollywood way one recent Friday evening but Lloyd Bruce Smith, apparently known to his intimates at "Ted", which in case you have never heard is short for Bruce. This good looking and nice mannered young chap, when he is not playing golf, occupies himself by officiating as the president of that considerable institution—the A. O. Smith Company. He was at the moment being convoyed in the wake of Bing Crosby, Bob Hope, Edgar Bergen, Gregory Peck, and Gary Cooper by another bright luminary of stage and scream, to wit, Hal "Deet" Detrick, western vice president of the Smith enterprises, and a meanie with a mashie if we ever saw one. Getting back to Ted, however, we read in his horoscope that the lad was born in Milwaukee, Wisconsin, graduated from Sheffield Scientific School of Yale University in industrial administration, and has been a stout adherent of the A. O. Smith cause ever since.

He began his business career in Milwaukee but later went to Kankakee where he had charge of a water project that Deet had just left to fuss with bigger and better things. Upon his return to the beer capital he was named vice president and a year or so ago was elevated to the presidency. In his spare moments Ted does a bit of "muskie" fishing in Northern Wisconsin and believes it to be the biggest sport in the world—next to playing gin rummy with Deet. He also enjoys a game that resembles golf in several minor respects which he plays occasionally at the Milwaukee Country Club. He is a good mixer and, in fact, as a guest of the Nineteeners during his brief business trip to Los Angeles he made such an impression that when we inadvertently referred to him as "Mitch" we were fined abominably by Big Shot Dale Russell.

Reduce Obsolescence in your plant



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● Brown Fintube's interchangeability of parts, exacting design and precision manufacture has "licked" obsolescence.

The sections can be used in one bank after another — on different duties — and different products. A bank can even be broken up and the sections shipped to two or more plants, miles apart, re-assembled and reused. Sections not in use serve as "stores" for other sections on stream. They are never obsoleted by changes in duty or plant re-arrangements. You can use and reuse them until they are completely worn out. Estimates and quotations furnished promptly. ***Write for Bulletin No. 481.***

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Sectional Hairpin Heat Exchangers
Tank Suction and Line Heaters
Fintube Heaters for Bulk Storage Tanks
Indirect Process Air Heaters
Fintube Heaters for Processing Tanks
Integral Welded Fintubes for Any Heating, Cooling or Heat Transfer Service

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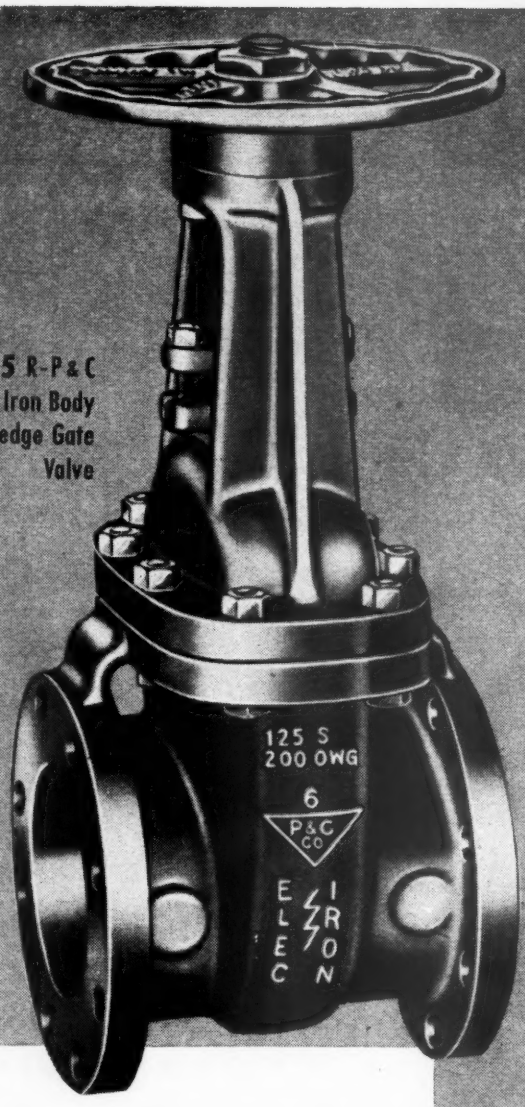

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● Electric furnace cast iron—fine-grained with physical properties far exceeding minimum specifications.

Reinforcing tie ribs between bonnet and end flanges—added strength where needed.

Yoke cap construction—rugged, makes servicing easy.

Pressure tested—to assure satisfactory service from the start.

You pay no more for R-P&C Electric Iron Gate Valves. Be sure you get them. Order from your R-P&C distributor or write nearest R-P&C office.

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R-P&C valves

MEETINGS

April 2-3—**Oil and Gas Conservation Institute,** Norman, Oklahoma.

April 2-3—**Pacific Coast Gas Association,** Berkeley, California

April 2-4—**American Petroleum Institute,** division of production, Eastern district, Hotel William Penn, Pittsburgh, Pennsylvania.

April 3-5—**Short Course in Fundamentals of Lubricating Materials,** Case Institute of Technology and ASLE, Cleveland, Ohio.

April 7-9—**American Society of Lubrication Engineers,** annual meeting, Statler Hotel, Cleveland, Ohio.

April 7-10—**American Gas Association,** distribution, motor vehicles and corrosion conference, Hotel Benjamin Franklin, Philadelphia, Pennsylvania.

April 15-19—**Association of American State Geologists,** annual meeting, Tallahassee, Florida.

April 16-18—**National Petroleum Association,** semi-annual meeting, Hotel Cleveland, Cleveland, Ohio.

April 21-23—**American Petroleum Institute,** division of transportation, pipe line meeting, The Blackstone Hotel, Fort Worth, Texas.

April 21-24—**Convegno Nazionale del Metano and del Petrolio,** (National petroleum convention) Taormina, Italy.

April 21-24—**American Petroleum Institute,** safety and fire protection committees, Hotel Texas, Fort Worth, Texas.

April 24-25—**American Petroleum Institute,** division of production, Rocky Mountain district, Gladstone Hotel, Casper, Wyoming.

Aprli 28-29—**Independent Petroleum Association of America,** midyear meeting, Deshler-Wallick Hotel, Columbus, Ohio.

April 28-30—**American Oil Chemists Society,** spring meeting, Shamrock Hotel, Houston, Texas.

April 28-30—**Southern Gas Association,** annual convention, Galveston, Texas.

April 29-30—**American Petroleum Institute,** Board of Directors and executive committee, Mayo Hotel, Tulsa, Oklahoma.

April 30-May 1, 2—**Natural Gasoline Association of America,** annual convention, Rice Hotel, Houston, Texas.

May 5-7—**American Geophysical Union,** National Academy of Sciences and National Research Council, Washington, D. C.

May 7-9—**Industrial Waste Conference,** Purdue University, Lafayette, Indiana.

May 8-9—**Fourth Oil Recovery Conference,** Texas Research Committee, Austin.

May 9-10—**Interstate Oil Compact Commission.** spring meeting, Phoenix, Arizona.

May 11-14—**American Institute of Chemical Engineers,** regional meeting, French Lick Springs Hotel, French Lick, Indiana.

May 12-13—**American Gas Association,** natural gas department spring meeting, Biltmore Hotel, Los Angeles, California.

May 12-14—**Liquefied Petroleum Gas Association,** annual convention, Palmer House, Chicago, Illinois.

DESK AND DERRICK CLUB

Dallas, Texas chapter, First Thursday of the Month.

Houston, Texas chapter, First Thursday of the Month.

Jackson, Mississippi chapter, Third Tuesday of the Month.

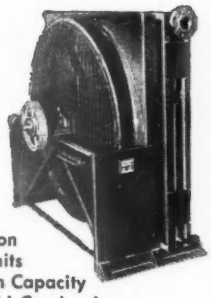
Los Angeles, California chapter, Third chapter of the Month.

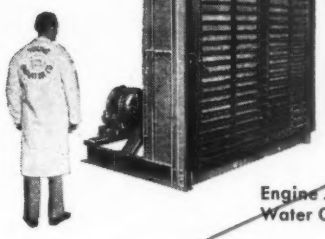
Odessa, Texas chapter, First Monday of the Month.

Shreveport, Louisiana chapter, Second Tuesday of the Month.

To obtain more information on products advertised see page E-51

"CC" Combination Cooling Units for Medium Capacity Cooling and Condensing





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"HSC" Spiral Tube Type Large Capacity Cooling and Condensing Units

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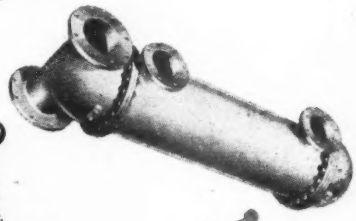
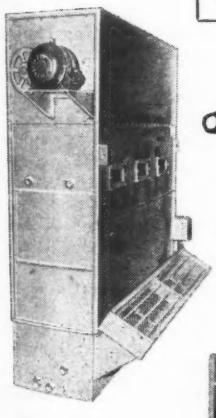


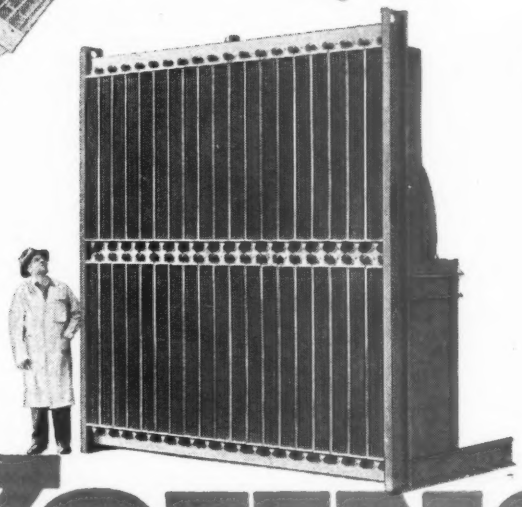
Fixed and Removable Type Shell and Tube Heat Exchangers



Evaporative Type Coolers and Condensers

"Mono-Weld" Sectional-Type Steel Tank and Side-Member Radiators

"HC" Tube and Fin Type Large Capacity Cooling and Condensing Units



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Other Representatives in Principal Cities.

To obtain more information on products advertised see page E-51

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"ATLAS"
CHROME-CLAD
OIL GAGING
TAPE

the finest tape
designed especially
for tank gaging

EASY TO READ
MARKINGS
THAT ARE *DURABLE*

C1290S
Series with
590 bob

- The line is 50% heavier than standard weight
- Sharply tapered 20-ounce solid brass plumb bob penetrates heavy oils—gives instant, accurate reading
- Easy to read permanent jet black markings are clear and sharp on the chrome white background
- Chrome-Clad—exclusive Lufkin process—gives a line that won't crack, chip, or peel. Resists rust and corrosion
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- Case hardened steel frame, hardwood carrying handle
- Available in 25, 33, 50, 66, 75 and 100 ft. lengths

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179

The Lufkin Rule Co., Saginaw, Michigan

132-138 Lafayette St., New York City • Barrie, Ontario

May 12-15—**American Petroleum Institute,** refining division midyear meeting, St. Francis Hotel, San Francisco, California.

May 15-16—**American Petroleum Institute,** division of production, Pacific Coast, Biltmore Hotel, Los Angeles, California.

May 16—**American Petroleum Institute,** symposium on oil and gas, University of Kansas City, Missouri.

May 21-23—**Oil Industry Information Committee,** St. Francis Hotel, San Francisco.

May 22-23—**European Association of Exploration Geophysicists,** London, England.

May 26-28—**American Gas Association,** production and chemical conference, Hotel New Yorker, New York City, N. Y.

May 26-28—**American Petroleum Institute,** division of marketing, lubrication committee, Mayo Hotel, Tulsa, Oklahoma.

May 27-29—**Southwestern Gas Measurement Short Course,** University of Oklahoma, north campus, Norman, Oklahoma.

May 28-30—**Short Course in Gas Technology,** seventh annual, Texas College of Arts and Sciences, Kingsville, Texas.

June 1-6—**Society of Automotive Engineers,** Ambassador and Ritz-Carlton, Atlantic City, New Jersey.

June 5-6—**American Gas Association,** research and utilization conference, Hotel Statler, Cleveland, Ohio.

June 5-6—**Pennsylvania Grade Crude Oil Association,** annual meeting, Hotel William Penn, Pittsburgh, Pennsylvania.

June 5-7—**National Oil Scouts and Landmen's Association,** annual convention, Hotel Hilton, Albuquerque, New Mexico.

June 8-12—**Canadian Gas Association,** Chateau Frontenac, Quebec City, Canada.

June 9-14—**American Petroleum Institute,** midyear standardization conference, Brown Plaza Hotel, Denver, Colorado.

June 23-27—**American Society for Testing Materials,** annual meeting, Hotels Statler and New Yorker, New York City, New York.

July 1-Sept. 30—**Centennial of Engineering,** Museum of Science and Industry, Chicago.

Aug. 31-Sept. 2—**Interstate Oil Compact Commission,** summer meet, Banff, Canada.

Oct. 4—**John Zink process heating seminar,** John Zink Company, Tulsa, Oklahoma.

Oct. 13-15—**Texas Mid-Continent Oil and Gas Association,** thirty-third annual meeting, Fort Worth, Texas.

Nov. 10-13—**American Petroleum Institute,** annual meeting, Chicago, Illinois.

Dec. 1-6—**National Exposition of Power and Mechanical Engineering,** Grand Central Palace, New York City, N. Y.

Dec. 7-10—**American Institute of Chemical Engineers,** annual meeting, Hotels Cleveland and Carter, Cleveland, Ohio.

NOMADS TO MEET

New York, N. Y., Chapter, First Monday of the Month, Louis Sherry's, New York. Secretary Fred J. Jobst, c/o Val A. Wittich, Jr., 30 Rockefeller Plaza, New York 20, New York.

Houston Chapter, Second Monday of the Month, Ye Olde College Inn, Houston, Texas. Secretary E. F. Baldwin, Hughes Tool Company, Box 2539, Houston, Texas. WO-3101.

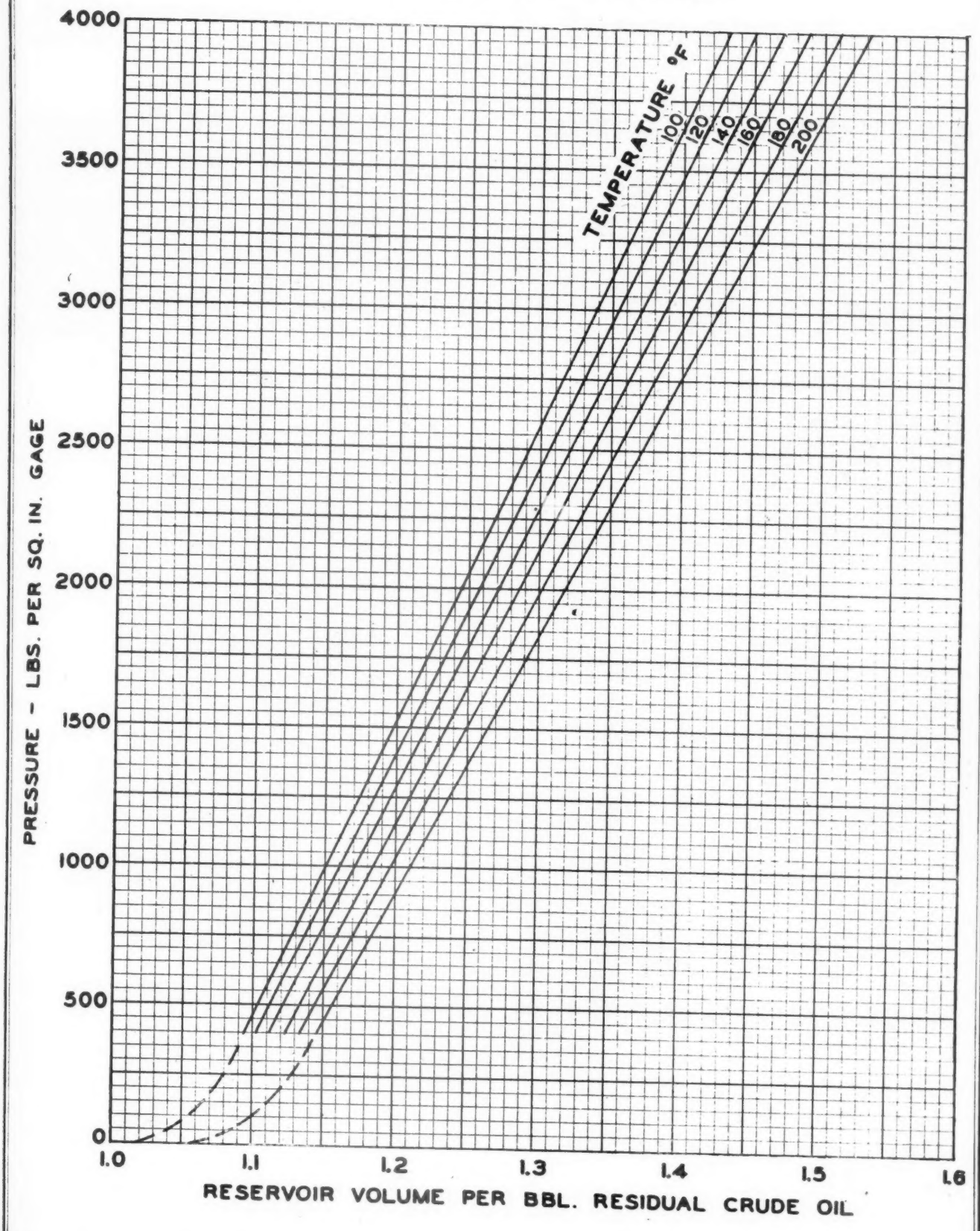
Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Secretary W. A. Wilson.

Tulsa Chapter, Third Friday, "After Five" Room, Hotel Tulsa. Secretary R. E. Kirkberger, Unit Rig Manufacturing Company, Tulsa, Oklahoma.

Dallas-Fort Worth Chapter, Dallas, Texas. First Monday of the Month. Secretary Gene Shiels, 205 Irwin-Keasler Building, Dallas, Texas. RI-4042.

RESERVOIR VOLUME OCCUPIED BY OIL AND DISSOLVED GAS

—Chart by George Granger Brown, University of Michigan.



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You've only to look into a Fluor Counterflo Cooling Tower for the proof of quality—quality of design, of manufacture, of performance, and of appearance. The points illustrated below are just a few of the many features that have earned Fluor Towers their enviable reputation for quality—compare them when next you buy or specify.

GRID DECKS

Rugged sloping-bar grid decks are of rough-finished 1" thick select redwood—will withstand repeated washing and cleaning and are sufficiently strong to support a man's weight or the abuse of removing and replacing. Prefabrication and structural strength permit use of grid decks as scaffolding during erection.

DRIFT ELIMINATORS

Fluor Drift Eliminators are designed for minimum resistance to air flow induced through the tower. Two-pass, zig-zag pattern removes entrained water droplets from the air stream and controls drift loss to less than 0.2 of 1 per cent of water circulated.

STACK and FAN ASSEMBLY

5' high fan stack of 2" thick tongue-and-grooved redwood staves, rigidly ringed with steel angles and straps. Fan stack is supported on heavy, bell-mouthed metal ring—Drive shaft, couplings, right-angle reduction gear and stainless steel fan blades assure long life and low maintenance—Patented Vibration Cut-Out Switch guarantees safety.

DISTRIBUTING SYSTEM

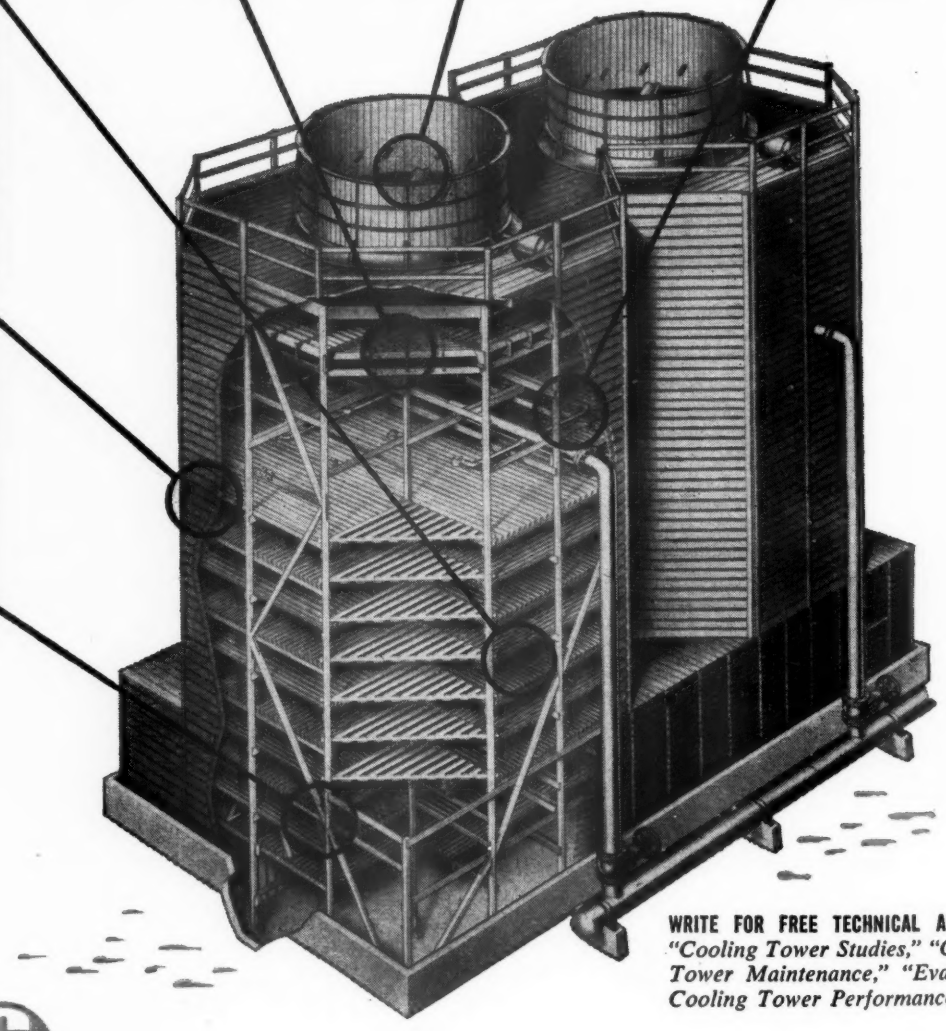
Upspray chamber flashes an appreciable portion of heat load as water enters the tower. Patented, non-clogging, self-draining Spirodome nozzles insure water break-up under nominal pressure. Nozzle spacing controls uniform water distribution. Cell distributing systems are independent to assure maximum control efficiency of water being cooled.

DOUBLE-WALL SHEATHING

Panels of sheathing are prefabricated in uniform sizes to enable fast, easy installation. Inner wall is of 1" tongue-and-groove redwood—outer wall is of 3/8" battens spaced 1-1/16" apart—2" spacing between walls permits air circulation and prevents dry rot.

TOWER STRUCTURE

Rugged 4" x 4" posts with 4" x 4" and 2" x 4" bracing—Corrosion-proof bolted internal gusset plate structural joints take both tension and compression for extra safety under all conditions. Posts are on 6' centers. Columns and bracing are designed with forethought to future tower extension—panels are reusable on new extension—bracing and columns need no modification.



WRITE FOR FREE TECHNICAL ARTICLES: *"Cooling Tower Studies," "Cooling Tower Maintenance," "Evaluating Cooling Tower Performance."*

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DATA ON IMPORTANT OIL FIELDS OF THE UNITED STATES

No.	Year discovered	Field	County	Producing formation	Gravity °API	Productive acres	Estimated Average thickness (feet)
				ILLINOIS (Cont.)			
18	1939	Iola	Clay	Aux Vases, Tar Springs, Cypress Paint Creek, Bethel; Miss. U.	35.6	1,500	14
19	1940	Iron	White	Tar Springs, Hardinsburg, Cypress, McClosky	38.5	1,000	18
20	1940	Irvington	Washington	Cypress, Bethel, Aux Vases; Miss. U, Dev	38.0	920	10
21	1941	Johnsonville	Wayne	Aux Vases, McClosky, O'Hara.	39.4	6,000	15
22	1939	Keensburg Consol	Wabash	Cypress, Biehl, McClosky; Pen, Miss. L, Dev	38.5	1,940	17
23	1937	Loudon	Effingham, Fayette	Cypress, Paint Creek, Bethel, Devonian	37.0	20,650	15
24	1943	Marine	Madison	Silurian	37.6	1,160	5
25	1940	Mattoon	Coles	Cypress, Rosiclare, McClosky; Miss. L & U	39.0	1,960	10
26	1939	Mill Shoals	White, Hamilton, Wayne.	Aux Vases, L O'Hara, Rosiclare, McClosky; Miss. L	38.8	1,950	10
27	1940	Mt. Carmel	Wabash	Cypress, Biehl, Waltersburg, Tar Springs; Miss. U	37.8	5,900	15
28	1939	New Harmony Consol	White, Wabash	Jamestown, Biehl, Waltersburg, Tar Springs, Cypress, Benoist, Aux Vases	37.0	8,900	20
29	1937	Noble	Clay, Richland	Cypress, McClosky, O'Hara, Aux Vases	38.7	5,600	10
30	1938	Noble, North	Richland	Cypress, McClosky; Miss. U & L	38.4	1,850	18
31	1940	Omaha	Gallatin	Palestine, Tar Springs	26.0	350	18
32	1941	Parkersburg Consol	Edwards, Richland	Cypress, Bethel, L O'Hara Rosiclare, McClosky, Miss. L	38.0	1,680	10
33	1937	Patoka	Marion	Bethel, Rosiclare, Devonian	40.0	1,000	22
34	1941	Patoka, East	Marion	Cypress, Bethel	36.1	500	14
35	1939	Phillipstown Consol	White	Tar Springs, Benoist, Rosiclare, Clor, Palistine; Pen, Dev	37.0	2,760	12
36	1940	Roland	Gallatin, White	Waltersburg, Tar Springs, Cypress ,Paint Creek, Bethel, Aux Vases; Miss. U	38.0	2,500	14
37	1941	Rural Hill	Hamilton	Cypress, Paint Creek, Bethel, Aux Vases, Lower O'Hara, Rosiclare; Miss. L & U	38.5	3,100	20
38	1939	St. James	Fayette	Cypress; Miss. U	34.4	1,900	16
39	1938	Salem	Marion	Bethel, Aux Vases, Rosiclare, McClosky, Salem, Devonian, Trenton	39.0	9,600	40
40	1941	Sims	Wayne	Aux Vases, L O'Hara, Rosiclare, McClosky; Miss. L & U	39.0	2,680	11
41	1939, 45	Stokes	White	Tar Springs, Cypress, Paint Creek, Bethel, Aux Vases, Lower O'Hara; Miss. U & L	37.2	2,100	15
42	1939	Storms	White	Waltersburg, Cypress, Palm Creek	37.9	1,790	25
43	1939	Tonti	Marion	Bethel, Aux Vases, McClosky; Dev, Miss. L & U	39.0	710	19
44	1941	Walpole	Hamilton	Tar Springs, Aux Vases	38.0	1,500	20
45	1940	Woodlawn	Jefferson	Cypress, Bethel, Aux Vases; Dev, Miss. U	37.5	1,480	16
				INDIANA			
1	1940	Caborn & West	Posey	Walterburg, Tar Springs; Miss. U	27.0-34.0	500	11
2	1938	Griffin	Posey, Gibson	Aux Vases, McClosky, Waltersburg, Tar Springs, Cypress	30.0-38.0	5,000	17
3	1938	Heusler	Posey, Vanderburgh	Tar Springs, Waltersburg	35.5	600	25
4	1941	Mt. Vernon	Posey	Waltersburg, Cypress	36.0	310	20
5	1939	New Harmony, incl S & E	Posey	Waltersburg, Tar Springs, Cypress, McClosky	37.5	910	17
6	1943	Owensville, No.	Gibson	Cypress, Bethel	37.5	840	11
7	1937	Prairie Creek	Vigo	Niagaran	37.0	400	20
8	1886	Trenton	(Numerous)	Trenton	36.0	130,140‡	10
9	1944	Upton	Posey	Waltersburg, Tar Springs, Aux Vases	36.0	300	8
				KANSAS			
1	1935	Bemis-Shutts	Ellis	Arbuckle; Ord	34.6	9,000	8
2	1935	Big Creek	Russell	Lansing—K. C., Gorham, Arbuckle; Ord, Pen	29.5	9,000	5–42
3	1936	Bloomer	Barton	Arbuckle; Ord	42.6	5,000	8

*Abandoned in 1940, revived in 1941.

†Brownsville included 1945 and on.

‡–Estimated.

From *The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.*

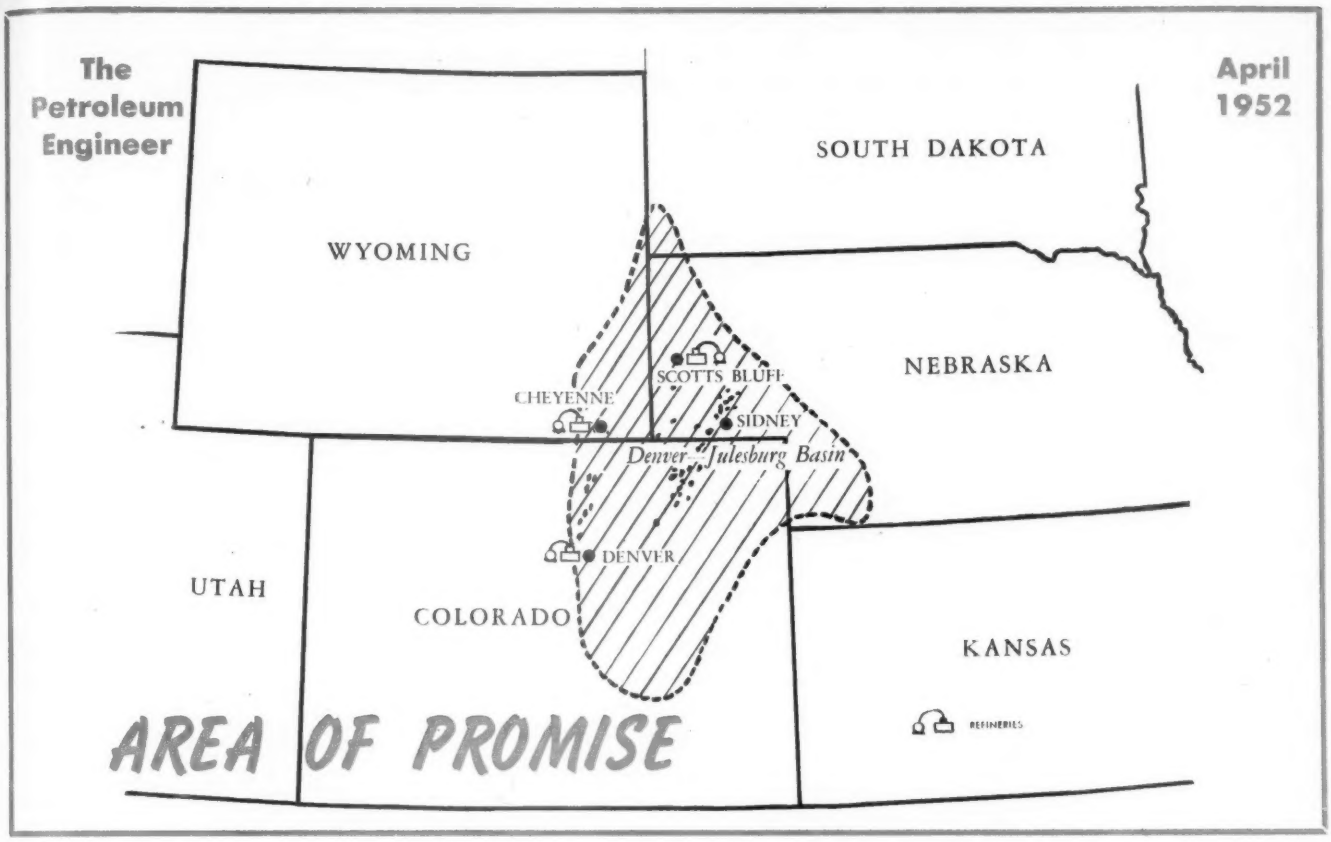
DATA ON IMPORTANT OIL FIELDS OF THE UNITED STATES

No.	Annual production (thousands of barrels)						Cumulative production thru 1947 (M bbl)	Estimated recovery per acre (bbl)	Number wells producing		
	1942	1943	1944	1945	1946	1947			Total	Flowing	Pumping
							ILLINOIS (Cont.)				
18	2	1,008	1,079	735	573	480	3,887	2,271	—	—	—
19	472	311	240	181	127	114	3,363	3,249	53	0	53
20	749	551	437	358	315	271	4,235	4,309	80	0	80
21	5,136	2,199	1,425	1,800	1,198	941	19,301	3,060	—	—	—
22	1,704	1,142	868	436	355	350	7,316	3,591	171	0	171
23	17,966	13,651	11,271	9,380	8,205	7,379	137,572	6,305	—		—
24	0	18	479	828	1,202	1,058	3,585	2,179	—	—	—
25	6	10	28	445	4,271	2,058	6,835	2,437	379	0	379
26	906	412	476	351	298	428	4,528	2,103	—	—	—
27	1,019	871	1,330	834	858	623	7,355	1,141	—	—	—
28	7,251	5,065	4,400	3,763	3,183	3,490	42,579	4,392	875	0	875
29	2,548	2,509	3,593	2,699	1,858	1,447	23,079	3,863	—	—	—
30	440	424	355	324	287	362	4,257	2,105	109	0	109
31	256	183	153	137	139	136	1,375	3,540	18	0	18
32	1,366	685	447	375	513	743	4,962	2,511	—	—	—
33	343	298	630	1,309	1,644	1,352	8,073	6,721	—	—	—
34	680	470	361	286	236	198	2,894	5,392	52	0	52
35	205	1,134	1,012	1,247	1,005	873	5,601	1,713	163	0	163
36	1,887	1,104	839	959	748	645	7,278	2,653	—	—	—
37	3,726	1,711	909	690	577	779	10,008	2,977	—	—	—
38	1,477	1,128	921	791	704	634	9,833	4,842	—	—	—
39	14,786	10,659	8,197	6,711	5,905	5,243	203,298	20,631	—	—	—
40	75	950	490	329	248	201	3,881	1,373	62	0	62
41	414	513	412	500†	1,941	1,119	5,155	1,922	164	0	164
42	729	460	341	284	358	355	5,474	2,860	142	0	142
43	859	689	597	479	424	430	8,189	10,928	52	0	52
44	703	900	717	572	461	322	3,884	2,375	66	0	66
45	2,998	1,436	837	967	794	690	10,348	6,526	—	—	—
							INDIANA				
1	249	219	171	145	159	135	1,224	2,178	43	0	43
2	3,509	2,393	2,004	1,726	1,740	1,433	22,233	4,160	458	0	458
3	235	273	145	135	148	110	1,582	2,453	43	0	43
4	729	483	379	404	363	314	2,672	7,606	24	0	24
5	1,676	528	396	464	1,574	612	5,316	5,169	126	0	126
6	—	39	234	164	743	278	1,465	1,413	74	0	74
7	85	94	59	53	52	49	907	2,145	13	0	13
8	20‡	20‡	21‡	48‡	35‡	75	104,958	806	1,305	0	1,305
9	0	0	107	220	173	83	583	1,667	16	0	16
							KANSAS				
1	5,298	5,066	6,233	5,136	5,365	6,055	49,099	4,783	—	—	—
2	1,457	437	413	1,130	1,349	761	10,151	1,043	142	0	142
3	2,487	2,275	4,614	2,852	2,803	3,038	27,402	4,873	—	—	—

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

The Petroleum Engineer

April 1952



East Side of the Julesburg Basin

First Nebraska oil field was discovered in 1949 and exploration and development continues actively in the Rocky Mountain Region

R. W. McCANNE

SINCE the original discovery of oil in the Gurley field, Cheyenne County, Nebraska, June, 1949, the tempo of the exploration and development of oil and gas reserves in this new producing province, located along the eastern flank of the Julesburg Basin principally in Southwestern Nebraska and Northeastern Colorado, continues to increase until at this time the Julesburg Basin is the most active province in the Rocky Mountain region for all forms of oil and gas activity.

To bear this out, the following is a tabulation by years of the discoveries in the several states from 1949 to date. See Fig. 1, which tabulates the discoveries by years, and Fig. 2, which shows location of discoveries.

Year	Southwestern Nebraska	Northeastern Colorado	Wyoming	Total
1949	1	0	0	1
1950	6	7	0	13
1951	15	15	1	31
1952*	1	2	0	3
Total	23	24	1	48

*To January 25, 1952.

Development in these 48 fields is in various stages from almost complete development in one or two fields to some fields in which the discovery well is still testing as in the three fields that have been discovered so far in 1952.

A breakdown by states showing the number of oil and gas producing wells in these 48 fields is as follows:

Southwestern Nebraska		Northeastern Colorado		Wyoming		Total	
Oil	Gas	Oil	Gas	Oil	Gas	Oil	Gas
88	26	123	12	1	0	212	38
Total Producing Wells							250

Coincident with the finding of these 48 fields, some 275 odd non-productive wildcat wells have been drilled: 138 in Southwestern Nebraska. 120 in Northeastern Colorado, 17 Wyoming. This does not include the non-productive field wells, the number of which per field is somewhat above the Rocky Mountain average.

Coupled with this intensified drilling campaign, there has been an ever-increasing number of companies and individuals that have become interested in the Basin, and the result has been that the scramble for land has reached such a degree that 85 per cent to 95 per cent of the land is now under lease in the active part of the Basin. In order to evaluate the millions of acres under lease, seismic activity has, of course, kept pace with all other forms of activity. As of the first of the year, some 47 seismic crews were active in the Basin and probably as Spring arrives, this number will be increased.

At the present time, the estimated total restricted daily oil production from the 48 fields is in the neighborhood of 14,440 bbl, divided as follows: 6340 bbl from Southwestern Nebraska and 8100 bbl from Northeastern Colorado. This compares with an estimated total M.E.R. of some 38,240 bbl, divided as follows: 14,680 bbl per day from Southwestern Nebraska and 23,560 bbl per day for Northeastern Colorado.

Due to inadequate pipe line outlets in most cases, the take is in the neighborhood of 50 bbl per well per day. At the

EXCLUSIVE

FIG. 1. STATUS OF FIELDS DISCOVERED IN SOUTHWESTERN NEBRASKA AS OF JANUARY 25, 1952

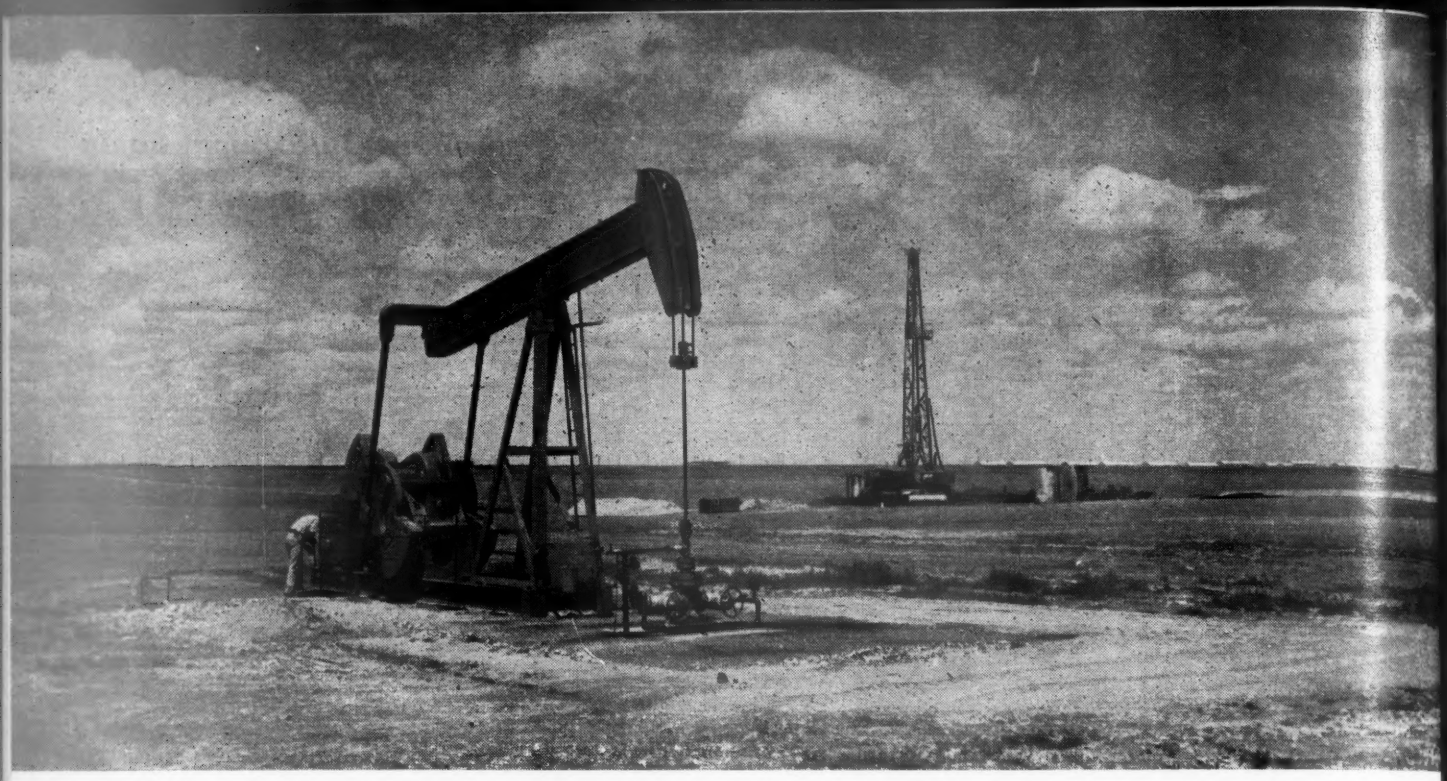
Field or Area	Operator that drilled discovery well	Date of discovery	Location of discovery well	Producing formations	Approximate depth of producing formation	Number of productive oil wells drilled to date	Number of productive gas wells drilled to date	Method of locating structure	Remarks
Gurley	Ohio	June 1949	11-15N-49W Cheyenne Co.	1st Dakota or D Sand 1 well 3rd Dak-J sand	4400′ –D–	18	0	Seismic.	
Huntsman	Ohio	Jan. 1950	7-14N-49W Cheyenne Co.	1st Dakota or D sand. 3rd Dakota or J sand.	4600′ –D– 4750′ –J–	27	8	Seismic.	Third Dakota or J sand gas unitized.
McLernon	Ohio	June 1950	9-14N-49W Cheyenne Co.	1st Dakota or D sand.	4500′ –D–	3	0	Seismic.	
Dorman	Ginther-Warren -Ginther et al	July 1950	23-14N-50W Cheyenne Co.	1st Dakota or D sand. 3rd Dakota or J sand.	4690′ –D– 4800′ –J–	15	2	Seismic.	
W. Big Springs	Ideal Drlg. Co.	Sept. 1950	19-13N-42W Deuel Co.	1st Dakota or D sand.	3300′ –D–	0	10	Geophysics.	
Sunol	Ohio	Oct. 1950	2-14N-48W Cheyenne Co.	1st Dakota or D sand.	4350′ –D–	0	1	Seismic.	Shut-In gas well. Well drilled to granite 6814′.
West Sidney	H. P. Macauley et al	Oct. 1950	12-13N-51W Cheyenne Co.	1st Dakota or D sand.	4670′ –D–	0	2	Seismic.	Two gas wells shut in.
Dalton	Reco Oil Co. et al	Feb. 1951	30-17N-49W Cheyenne Co.	3rd Dakota or J sand.	4700′ –J–	2	0	?	
Harrisburg	Kerr McGee Stanolind et al	Mar. 1951	6-18N-55W Banner Co.	3rd Dakota or J sand.	5875′ –J–	3	0	Seismic.	
Marlow	Ohio	Mar. 1951	29-15N-49W Cheyenne Co.	1st Dakota or D sand. 2nd Dakota or G sand.	4500′ –D– 4550′ –G–	2	2	Seismic.	One well producing oil from Second Dakota. First Dakota all gas.
Johnson	Ohio	May 1951	35-15N-49W Cheyenne Co.	1st 2nd + 3rd Dak. or D-G-J sands	4460′ –D– 4500′ –G– 4570′ –J–	2	—	Seismic.	No wells completed in Second Dakota.
Reimers	Ohio	Aug. 1951	15-16N-50W Cheyenne Co.	3rd Dakota or J sand.	4800′ –J–	4	0	Seismic.	
Kimball	Nebraska Drillers	Aug. 1951	23-14N-56W Kimball Co.	3rd Dakota or J sand.	6525′ –J–	2	0	?	
S. Harrisburg	Stanolind	Aug. 1951	18-18N-55W Banner Co.	3rd Dakota or J sand.	6060′ –J–	1	0	Seismic.	
Harrison	Gulf	Sept. 1951	18-12N-58W Kimball Co.	3rd Dakota or J sand.	7330′ –J–	1	0	Seismic.	
S. W. Potter	Wytex Pet-Derby Oil	Sept. 1951	3-13N-53W Kimball Co.	1st Dakota or D sand. 3rd Dakota or J sand.	5530′ –D– 5650′ –J–	2	0	?	
McCourt	Brown Drlg.	Sept. 1951	11-15N-48W Cheyenne Co.	1st Dakota or D sand.	4155′ –D–	1	0	Seismic.	
N. W. Peetz	Saltmount and Davon	Sept. 1951	17-12N-52W Cheyenne Co.	3rd Dakota or J sand.	5375′ –J–	0	1	?	Shut-In gas well.
E. Brownson	Ohio	Oct. 1951	17-14N-50W Cheyenne Co.	1st Dakota or D sand.	4760′ –D–	1	0	Seismic.	
Enders	Twin Oil + Rock Hill	Nov. 1951	15-13N-55W Kimball Co.	3rd Dakota or J sand.	6304′ –J–	1	0	Seismic.	
W. Dalton	Olds Oil + Gen. Prod.	Nov. 1951	32-17N-49W Cheyenne Co.	3rd Dakota or J sand.	4680′ –J–	1	0	?	
N. Sidney	Gulf Plains	Dec. 1951	19-14N-49W Cheyenne Co.	1st Dakota or D sand.	4720′ –D–	1	0	Seismic.	
Kugler	Ohio	Jan. 1952	5-14N-48W Cheyenne Co.	1st Dakota or D sand. 3rd Dakota or J sand.	4385′ –D– 4530′ –J–	1	0	Seismic.	Still testing gas in D sand, oil in J sand
Totals						88	26		

FIG. 1. STATUS OF FIELDS DISCOVERED IN NORTHEASTERN COLORADO AS OF JANUARY 25, 1952

Field or Area	Operator that drilled discovery well	Date of discovery	Location of discovery well	Producing formations	Approximate depth of producing formation	Number of productive oil wells drilled to date	Number of productive gas wells drilled to date	Method of locating structure	Remarks
Armstrong	British-Am.	June 1950	26-11N-53W Logan Co.	1st Dakota or D sand. 3rd Dakota or J sand.	5275′ –D– 5400′ –J–	1	4	Seismic.	
Merino	Goodstein	July 1950	19-6N-54W Logan Co.	3rd Dakota or J sand.	5075′ –J–	18	0	Seismic.	
Fort Morgan or (Adam Lee)	Adams Drlg. et al	Sept. 1950	2-2N-57W Morgan Co.	1st Dakota or D sand. 3rd Dakota or J sand.	5475′ –D– 5545′ –J–	2	2	?	Discovery well later drilled deeper and abandoned.
Buckingham	Shell	Sept. 1950	33-8N-59W Weld Co.	1st Dakota or D sand.	6720′ –D–	3	0	Seismic.	
Yenter	British-Am.	Nov. 1950	3-8N-54W Logan Co.	3rd Dakota or J sand.	5240′ –J–	37	0	Seismic.	
Mount Hope	Shell	Nov. 1950	30-9N-54W Logan Co.	1st Dakota or D sand.	4870′ –D–	23	0	Seismic.	
Walker	British-Am.	Dec. 1950	21-9N-53W Logan Co.	3rd Dakota or J sand.	4925′ –J–	12	1	Seismic.	
Little Beaver	Orin Tucker et al	Mar. 1951	1-2S-57W Adams Co.	1st Dakota or D sand. 3rd Dakota or J sand.	5190′ –D– 5262′ –J–	0	1	?	Shut In gas well.
Messex	Reco Oil + C. E. Stout	May 1951	36-6N-55W Morgan Co.	3rd Dakota or J sand.	5050′ –J–	2	0	?	Suspended operations.
Graylin	British-Am.	May 1951	7-8N-53W Logan Co.	1st Dakota or D sand. 3rd Dakota or J sand.	4880′ –D– 4990′ –J–	7	0	Seismic.	
Arford	British-Am.	June 1951	28-9N-54W Logan Co.	3rd Dakota or J sand.	5280′ –J–	1	0	Seismic.	
Atwood	Ginther-Warren-Ginther	Aug. 1951	20-7N-53W Logan Co.	3rd Dakota or J sand.	4690′ –J–	4	1	Seismic.	
W. Sterling	Plains Expl. Co.	Aug. 1951	22-8N-54W Logan Co.	3rd Dakota or J sand.	5240′ –J–	2	0	Seismic.	
Keota	Wyo-Colo. Dev. Co.	Aug. 1951	4-9N-61W Weld Co.	3rd Dakota or J sand.	7350′ –J–	1	0	?	
Springdale	Shell	Sept. 1951	16-8N-53W Logan Co.	3rd Dakota or J sand.	4850′ –J–	1	0	Seismic.	
Padroni	Texas	July 1951	20-9N-52W Logan Co.	3rd Dakota or J sand.	4660′ –J–	0	2	Seismic.	Two gas wells shut in.
Noonen	Ginther-Warren-Ginther	Sept. 1951	24-3S-59W Adams Co.	3rd Dakota or J sand.	6190′ –J–	1	0	Seismic.	Discovery well testing.
Sand Creek	Sinclair O + G	Oct. 1951	19-7N-54W Logan Co.	1st Dakota or D sand.	5115′ –D–	3	0	Seismic.	
N. Greaswood	Joe Dyer + Gifford, Parker	Nov. 1951	12-6N-61W Weld Co.	1st Dakota or D sand.	6750′ –D–	1	0	?	
Goodrich	Shell	Nov. 1951	30-5N-60W Morgan Co.	3rd Dakota or J sand.	6510′ –J–	1	0	Seismic.	
Pawnee Creek	H. C. Arnold	Dec. 1951	3-7N-54W Logan Co.	3rd Dakota or J sand.	4945′ –J–	1	0	Seismic.	
Unnamed as yet	Sinclair O + G	Dec. 1951	6-9N-52W Logan Co.	3rd Dakota or J sand.	4785′ –J–	1	0	Seismic.	Possible discovery testing.
Unnamed as yet	Shell	Jan. 1952	28-8N-53W Logan Co.	3rd Dakota or J sand.	4856′ –J–	1	0	Seismic.	Possible discovery testing.
Unnamed as yet	British-Am.	Jan. 1952	6-11N-52W Logan Co.	1st Dakota or D sand. 3rd Dakota or J sand.	5144′ –D– 5299′ –J–	0	1	Seismic.	Possible discovery testing.
Totals						123	12		

FIG. 1. STATUS OF FIELDS DISCOVERED IN SOUTHEASTERN WYOMING AS OF JANUARY 25, 1952

Pine Bluffs	Union Oil of Calif.	Dec. 1951	31-14N-60W Laramie Co.	3rd Dakota or J sand.	7470′ –J–	1	0	?	Possible discovery, still testing.



Typical scene Huntsman field, Cheyenne County, Nebraska, showing the great expanse of flat wheat raising country. Wells shown are Ohio Oil Company's Gurschke No. 1 and No. 2.

present time the main outlet for the oil is the Service Pipe Line which passes diagonally across the north end of the producing area in Nebraska. The oil, or that part that does not have a ready market locally, is now trucked to Northport, Nebraska, for delivery to Service Pipe Line. This line, of course, does not have space for all the oil that might be efficiently produced, so a substantial amount of the potential production remains shut in awaiting a market. This condition is expected to be relieved during 1952 for the reason that during the last few months encouraging reports have come out of Washington, D. C., to the effect that the steel for the completion of the middle section of the Platte pipe line is assured, so the line should be completed sometime after mid-1952. Upon completion of the Platte Pipe Line and the field gathering systems and connecting subsidiary line, there should be a ready market for all the oil produced throughout the Basin that does not have a ready market locally.

During 1951 natural gas and related products also assumed considerable importance. In 1951, The Ohio Oil Company completed its Huntsman gasoline plant, rated at 12,500,000 cu ft per day, and since early February, 1951, has been removing the natural gasoline, butane, and propane from the gas, and delivering the residue gas to the North Central Gas Company, which constructed 25 miles, approximately, of combination 6- and 8-in. pipe line from the Huntsman field to Bayard, Nebraska, where the gas is delivered into North Central's distribution system up and down the North Platte River Valley. In addition, the towns of Sidney and Dalton were piped having the distinction of being the first Nebraska towns served with native Nebraska gas. In mid-1950, gas was discovered in the West Big Springs gas field, Deuel County, Nebraska, at the shallow depth of 3300 ft. and by the end of 1951, ten commercial gas wells had been completed. This gas is sold to the Kansas-Nebraska Gas Company for distribution to other towns in the vicinity of Big Springs and also down the North and South Platte River Valleys. During 1951, Brush, Colorado, in Morgan County, was also piped for natural gas by the Gas Producers, Inc., gas being piped through seven miles of 4-in. line from the Adams-Lee field situated about five miles south of Brush. About the same time, a gas distribution system was established for the town of Sterling, Logan County, Colorado, by the Iowa Electric Light and Power Company. A 19-mile, 8-in. line was constructed by the Public Service Company of Colorado to the Armstrong field located north of Sterling.

In addition to the above, there are a number of other gas reserves, principally in Cheyenne County, Nebraska, that are at present shut in waiting a market and further development. The two largest of these undeveloped reserves are the West Sidney and Marlow fields.

As shown on Fig. 1, there are 38 active gas wells compared with some 212 oil wells in the Basin, indicating that natural gas is going to exert more and more influence in the development of the Basin.

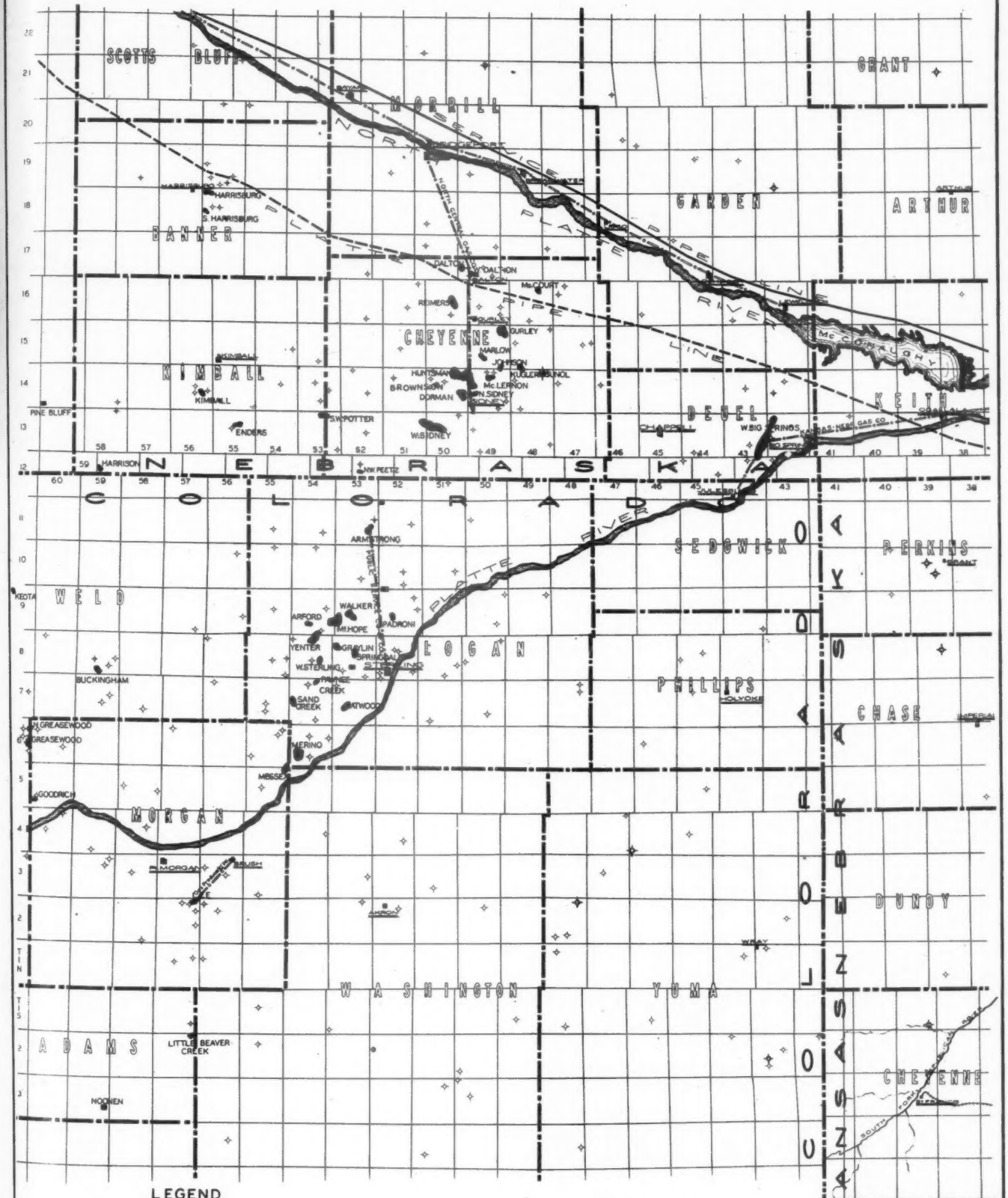
As stated above, the industry is anticipating this day by continuing to increase its activities in the Basin. There is a total of approximately 35 drilling rigs working in the Basin distributed as follows: 12 in Southwestern Nebraska, 22 in Northeastern Colorado, and 1 in Wyoming. More than half of these drilling rigs are engaged in drilling exploratory wells. The one factor that distinguishes drilling in the Julesburg Basin from drilling in most other parts of the Rocky Mountain region is the softness of the formations, the average drilling time for a mile-deep well in the Basin being about 15 days. Thus, an average drilling rig is usually able to drill about two wells a month, depending on the length of the move between locations.

After some two and one-half years' experience in the Basin, it is the general consensus of the operators that the majority of the fields are going to be rather limited in extent, but the fields found will undoubtedly be many.

With one possible exception, all the fields in the Basin now produce from the Dakota group of sands of Cretaceous age. This one exception is the Ben

The Author

R. W. McCanne is assistant manager of Ohio Oil Company's Casper division. A graduate of the University of Colorado, he did graduate work in geology at the University of Chicago and Columbia University in 1931 and 1932. In 1930 he joined Ohio Oil, and from that time until 1945 worked throughout the Rocky Mountain region as a geologist, becoming division geologist in 1945. McCanne was transferred to Ohio's general offices at Findlay, Ohio, as assistant to the manager of production in 1950. Late that year he moved to Casper, Wyoming, and was promoted to his present position. McCanne is probably the man most responsible for the discovery of oil in Cheyenne County, Nebraska.



LEGEND

- Producing Fields
- Probable Discovery (Discovery well testing)
- Dry Hole
- Main Oil Lines
- Main Oil Lines under Construction
- Deep Granite Test
- Deep Granite Test Drilling or Testing
- Gas Lines

FIG. 2

REGIONAL MAP OF A PART OF THE JULESBURG BASIN

SHOWING THE LOCATION OF THE PRODUCING FIELDS AND MAIN OIL AND GAS LINES

Scale in Miles

Note: The many dry holes drilled in the region are an indication of the cost of finding oil and gas today.

Denver-Julesburg Basin

F. Brack well No. 1 in Section 26, T. 1 S., R. 39 W., Cheyenne County, Kansas. The operator of this well has been trying to complete it for some time as a commercial producer from either the Lansing-Kansas City or Marmaton-Bronson section of the Pennsylvanian formation. Although this well was not included as a pool opener in the list of fields in Fig. 1, it is worthy of special mention because of the presence of oil in deeper formations in the well.

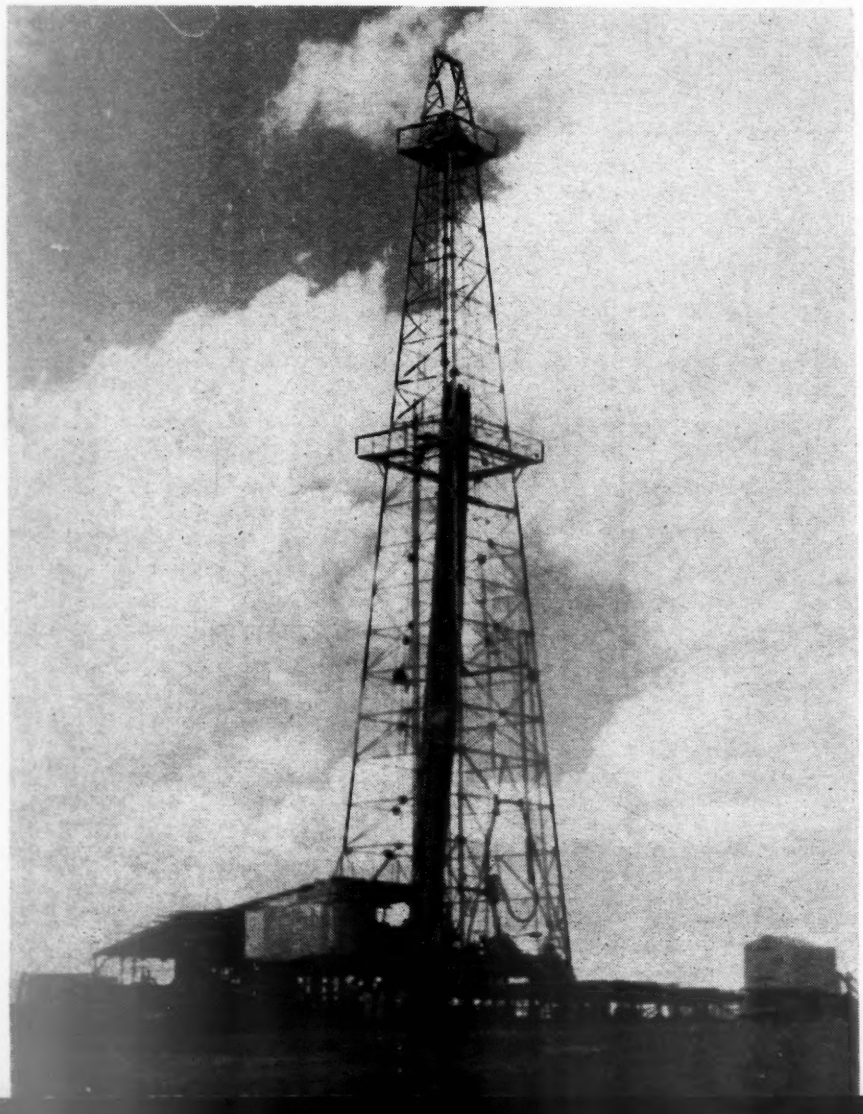
As in most sand production and particularly the Dakota group of sands of the Julesburg Basin, thickness of the sand bodies varies decidedly from place to place and lensing and pinch-out characteristics of sand bodies are the rule instead of the exception. Another factor typical of the Dakota group of sands in the Basin is the marked changes in porosity and permeability over comparatively short distances. But usually where the sands are well-developed, the porosity and permeability are remarkably good. Porosities of 25 per cent and permeabilities of 500 md are not uncommon in the good sand bodies.

In the usual low (less than 100 ft of closure) structural relief of the fields thus far found in the Basin, sand conditions play an important part in the accumulation of oil and gas. Thus, continued exploration is needed, to point out more definitely the relationship between sand conditions and structure, and to indicate more clearly the productive trends. In most every sand-producing area, good sand conditions have been found to run in trends. Most structural uplifts also run in trends. The ideal situation is, of course, to find the trends of good reservoir conditions coinciding with the trends of structural uplift. To what extent these ideal conditions exist in the Julesburg Basin is as yet not clearly determined. About all that can be said in this regard at this time is that there is at least one major structural trend extending from the Dalton area of Cheyenne County, Nebraska, for some 125 miles southwestward to the Noonen area of Adams County, Colorado. To date some 26 producing areas have been found aligned along this trend.

WESTERN NEBRASKA
TYPICAL OIL ANALYSIS

ASTM Tests		Steam Distillation		Typical Gas Analysis	
Gravity	35.0° API	Gasoline	22.51%	Oxygen	0%
BS & W	0.8%	No. 1 Distillate	11.93%	Nitrogen	8%
Water	0.9%	No. 3 Distillate	29.76%	Carbon dioxide	1%
Reed vap. press.	2.0 lb	Bottoms	32.78%	Hydrogen sulfide	0%
Sulfur	0.240%	Water	0.70%	Methane	78%
Color	Green	Loss	2.32%	Ethane	6%
Pour point	60° F		100.00%	Propane	5%
Flash	Instant			Isobutane	1%
S. U. visc.	80 Sec at 80° F			N-Butane	1%
				Isopentane	1%
				N-Pentane	1%
				Hexanes & Higher	0%
					100%
				Sp. gravity	0.73

Ohio's discovery well in Julesburg Basin, Mary Egging No. 1.



Brief History of Julesburg

The search for oil and gas has long been going on in the Julesburg Basin. Oil was first discovered in the Basin in 1862, just three years after Colonel Drake made his famous discovery at Titusville, Pennsylvania. This first discovery was made on the southwest rim of the Basin at Florence, Colorado, just east of Canon City, Colorado. The second discovery was also made on the west side of the Basin at Boulder, Colorado, in 1909. In both of these fields, oil was found in fractured shale, the accumulations being in stratigraphic rather than structural traps. It was not until 1922 that production was found in sands at Wellington, Ft. Collins, and Berthoud, Colorado.

After the discovery of the Wellington and Ft. Collins fields, most of the remaining anticlinal folds on the west or mountainward side of the Basin were drilled without success. It was not until 1930 that the next discovery of oil was made along the Morgan and Weld County line at Greasewood. This discovery was significant not for the amount of oil it produced, but for the fact that it proved the existence of oil on the east or gentle-dipping flank of the Basin. From 1930 to 1943 numerous non-productive exploratory wells were drilled throughout the Basin with the greatest concentration being on the east side of the Basin. Petroleum geologists were especially interested in these wells because of the unusually thick petroliferous shale sections penetrated and the thick reservoir sands of the Dakota group of sands. Many times it was brought to the geologist's mind that if folding could be found on the east rim of the Basin, the possibilities of finding commercial quantities of oil and gas would be good.

With this in mind, The Ohio Oil Company employed General Geophysical Company, of Houston, Texas, and initiated a seismic program that began in 1943, in northern Weld County, Colorado, and had continued it south past Greeley and eastward to Morgan, Logan, and Washington counties, Colorado, in

the vicinity of Sterling by 1944. In 1945 three Dakota sand non-productive exploratory wells were drilled on anomalies found by this work.

The second phase of The Ohio Oil Company's seismic exploration with General Geophysical the contractor began in early 1946 and has continued with few interruptions to the present time. This phase carried the seismic work eastward into Chase County, Nebraska, and northward through Perkins, Keith, Deuel, Cheyenne, and into Morrill and Garden counties. Structural conditions most favorable for the accumulation of oil were found in Cheyenne County, Nebraska, and the first leases were taken there in early 1948.

Early in 1949 one of the better anomalies found in Cheyenne County, Nebraska, with seismic closure in excess of 100 ft was chosen for a wildcat test. A rig, with drilling capacity in excess of 7500 ft was employed so that, if necessary, all formations down to the granite could be tested. On April 21, 1949, actual drilling of this wildcat began and within a short time the well had reached the First sand of the Dakota group at the shallow depth of 4401 ft. The well was the Mary Egging No. 1, NE-NE-NE 11-15N-49W. Twenty-eight feet of saturated sand was cored in the First Dakota or "D" sand, and the well was officially completed on August 9, 1949, for an initial production of 225 bbl per day of 36.1 API green oil. The newly-discovered field was called the Gurley field after the town of Gurley, Nebraska, 4½ miles to the north.

Limits of the Julesburg Basin

Eastern Colorado and adjacent parts of the Great Plains lying east of the Rocky Mountain Front are underlain by a broad structural depression called the Julesburg Basin[2] and named after the small town of Julesburg, in the extreme northeastern corner of Colorado in Sedgwick County. The outline of this great geosyncline is roughly egg-shaped with a length north and south of approximately 400 miles and a maximum width at the Fortieth Parallel of about 250 miles. Its limits are defined on the east by the Chadron-Cambridge and Las Animas Arches; on the south by the Apishapa Uplift; on the west by the Front Range of the Rockies and the Hartville Uplift; and on the north by the Black Hills. The Basin is asymmetrical, with its axis running very close to the Rocky Mountain Front, resulting in a steep-dipping west flank and a very gentle-dipping east flank. Seismic and drilled information indicates there are two areas of maximum downwarp, one centered at Denver and the other at Cheyenne. It is estimated that of the 100,000 odd square miles of land in the Basin, 50,000 square miles may eventually have prospects of being in the productive area. At the present time, more than 12,000 square miles are estimated to be within this area.

[2]USGS Bulletin 796B, Geology and Oil and Gas Prospects of Northeastern Colorado, Kirtly T. Mather et al.

Productive Province

The reserves of oil and gas that have thus far been found in the Julesburg Basin are all located on its east flank some 100 miles southwest of the Chadron-Cambridge Arch and about the same distance northwest of the crest of the Las Animas Arch. The productive area now extends over a distance of 125 miles in a general north-south direction from the Dalton area along the Cheyenne-Morrill County line to the Noonen area in Adams County, Colorado. In a general east-west direction, the productive trend extends from the West Big Springs gas field located in Deuel County, Nebraska, to the Keota area in Weld County, Colorado, a distance in excess of 100 miles.

Drilling depths to the top of the First Dakota or "D" sand range from the shallow depth of 3300 ft in the farthermost east field (West Big Springs gas field in Deuel County, Nebraska) to 7350 ft in the farthermost west field (the Keota field in Weld County, Colorado).

Surface Formations

The productive area of Southwestern Nebraska is completely covered by a blanket of Tertiary sediments that average approximately 1000 ft in thickness. This blanket of recent sediments conceals the structural attitude of the underlying Cretaceous sediments. In general, the regional dip of the Tertiary sediments is to the east at about one-half degree per mile, while the regional dip of the underlying Cretaceous sediments is about the same rate to the west.

Much of the southern half of the productive area, or that part south of the principal Tertiary Rim in Colorado, is devoid of Tertiary sediments, most wells beginning in the Cretaceous sediments or in a thin cover of alluvium above the Cretaceous.

Sub-surface Formations

Cheyenne County, Nebraska, is selected as the typical locality in which to describe briefly the sub-surface formations. Names of formations are those employed by the majority of the operators in the Basin. Fig. 3 below shows sub-surface stratigraphic thicknesses of various formations in descending order.

Below the Tertiary cover, formations down to the top of the Morrison are quite familiar, because they have now been drilled in so many wells throughout the Basin. The remainder of the section below the Morrison is not so familiar, because only 20 odd wells have thus far drilled a part of or all the remaining section. Of the deep tests thus far drilled, only one (Ben F. Brack No. 1, Section 26, T. 1 S., R. 39 W., Cheyenne County, Kansas) has found encouraging shows of oil and gas. The Brack well is reported to be testing substantial shows of oil in both the Lansing-Kansas City and Marmaton formations of Pennsylvanian age. Whether or not the well is commercial is unknown.

There is no reason to believe that in the deeper section the thick lime zones of the Big Blue, Shawnee, and Lansing-Kansas City formations might not carry commercial quantities of oil and gas in areas where favorable structural conditions exist; and, of course, the same applies to the Marmaton and Cherokee formations in which a number of good reservoir sands are present.

In other words, an exploratory well on a good seismic anomaly has not exhausted all its possibilities of obtaining commercial production until it has been drilled to the Basement Complex.

FIG. 3. Description of Formations.

Formation	Feet	
Pierre shale	3000	
Niobrara formation	304	Includes 40 ft of Ft. Hayes lime at the base.
Carlile formation	230	Includes 10 ft of Codell sand near the top.
Greenhorn lime	27	
Graneros shale	209	
First Dakota or "D" sand	55	Productive of oil or gas in 14 fields in Nebraska and 9 fields in Colorado.
Shale break	10	
Second Dakota or "G" sand	35	Productive of oil in 2 fields in Nebraska; probably not present in Colorado.
Shale break	35	
Third Dakota or "J" sand	75	Productive of oil or gas in 15 fields in Nebraska and 20 fields in Colorado.
"Skull Creek" shale	150	
First Lakota or "M" sand	16	
Shale break	46	
Second Lakota or "O" sand	10	Lakota sands contained good showing in two fields in Colorado.
Shale break	24	
Third Lakota or "R" sand	28	
Shale break	7	
Fourth Lakota or "T" sand	19	
Morrison	176	
Cimarron	478	Includes 20 ft of Stone Corral anhydrite.
Big Blue	515	Lime, dolomite, and anhydrite.
Topeka-Shawnee	125	Lime and sandy shale at base.
Lansing-Kansas City	180	Lime with siltstone and shale interbedded.
Bronson-Marmaton	270	Upper part lime and lower part shale.
Cherokee formation	118	Shale with good beds of sand.
Granite wash	4	

The Ohio Oil Company's Huntsman gasoline plant.

Seismic Exploration

As shown in Column 9, entitled "Method of Locating Structure," Fig. 1, the seismograph is the most accurate means of locating structure in the Basin; and, as a result of this fact, the amount of seismic work done is increasing. At the time of the initial discovery at Gurley a General Geophysical seismic crew employed by The Ohio Oil Company was the only seismograph crew working in Southwestern Nebraska and Northeastern Colorado. As stated above, there are now some 47 crews working in the active part of the Basin distributed as follows: Southwestern Nebraska 27, Northeastern Colorado 18, and Southeastern Wyoming 2.

On the whole, the Julesburg Basin is especially well adapted to seismic exploration—the terrain is gentle and the roads are numerous, particularly in the great wheat-raising areas. Water for drilling is plentiful, and the drilling is exceptionally easy. The over-all quality of the seismic records is above average. As a general rule, seismic work in the Basin is less expensive and is more accurate than the average seismic work in other parts of the Rocky Mountain region.

Land

The ownership of land in the Julesburg Basin differs considerably from that in other parts of the Rocky Mountain region. Most of the land in the Basin is privately owned, while in other parts of the Rocky Mountain region the Federal Government is the large landowner. For instance, in Wyoming about 60 per cent of the land is under Federal ownership. Nebraska, Colorado, and Wyoming control the usual two sections of land in each township. In Eastern Colorado and Wyoming, the Union Pacific Railroad is a substantial landowner due to its long standing land grant of each alternate section twenty miles on each side of the railroad right-of-way.

The continued success of the oil industry to find new fields, coupled with the low cost and relative ease of drilling in the Basin has, of course, intensified the leasing activity to the point where it is estimated that 85 to 90 per cent of the land in the indicated productive parts of the Basin is now under lease.

Drilling, Testing, Completion

To date, the drilling and completion of wells in the Basin offers few problems. As already stated, the formations are soft, and the drilling is fast. Penetration rates of 150 ft-per-hour are not uncommon; and, consequently, the number of drilling bits used is low. It is not unusual for the first bit under the surface pipe to drill 2000 to 3000 ft of hole. There is the record of one bit, a two-cone jet, which drilled 5929 ft of hole in 54 hours time on bottom, or in excess of 100 ft-per-hour.

In starting an exploratory well, the usual procedure is to drill a 15-in. hole to 250 ft and run and cement a string of 10¾-in. surface casing. The time involved is usually about 15 hours. Down time for cementing accounts for another 24 hours, and then a nine-inch hole is drilled to within 15 or 20 ft of the first objective, the First Dakota or "D" sand. Coring, either with wire line or a diamond barrel is begun at this point and usually continued on through the three sands of the Dakota and into the Lakota sand. If the cores indicate the presence of oil or gas, drill stem tests are made in the rat hole, usually using a double packer—one at the testing level and the other 8 ft above. This method usually insures satisfactory drill stem tests regardless of the unstable wall conditions of the hole.

After production is more or less assured, the most reliable method of completion is to run the production string of either 5-in. or 7-in. casing through the productive zone and set it with about 250 sacks of cement. Because the walls of the hole are soft, a good cement bond is difficult to obtain, and experience has indicated that before perforating the productive zone, it is best to perforate both above and below that zone and squeeze. This precaution insures a good cement job, and the productive zone may then be selectively perforated satisfactorily. The time involved in the actual drilling of the average 5000-ft hole should not exceed four to five days, and the down time, waiting on the cement to set around the production string, approximates 24 hours.

Because of the thick formations, composed chiefly of soft shales, there is a tendency for the bit to ball-up and the hole to wall-up, and this often results in stuck drill stem, especially when an attempt is made to withdraw the drill stem from the hole. To relieve this condition, the mud is held, by the addition of large quantities of water, to a 25 to 30 second viscosity and 15 c.c. water loss. In addition, "wiping the hole" is generally a necessity, especially in the soft calcareous shale sections of the Niobrara formation. Common practice is to pull the bit back to near the top of the formation after about each 100 ft of penetration, and then run back to bottom and drill ahead. Increasing the velocity of the mud in the annulus by increasing the size of the jet bit nozzles, and in some cases by entirely removing the nezzles from the bit, has also helped to keep the walls of the hole to gage.

The Future

As exploration and development proceed in the new producing province, certain factors seem to stand out rather prominently in their favor:

1. The present producing formations are at a comparatively shallow depth — around 5000 ft on the average, and the formations are soft and easy to drill, resulting in low drilling costs.
2. The prospective area that may have commercial oil and gas fields is very large in size, estimated by some to cover eventually as much as 50,000 square miles.
3. The oil is light gravity, has a paraffin base, and the gas is sweet and devoid of sulfur.
4. The new producing province is far out on the Great Plains, about 300 miles closer to Eastern markets than other reserves of oil and gas in the Rocky Mountain region.
5. The few wells that have thus far been drilled below the present producing formations indicate that there are good possibilities of obtaining oil and gas reserves in the deeper formations.
6. The completion of the Platte Pipe Line should provide a ready Eastern market for the oil that does not have a market locally in the Basin.

* * *

EXCLUSIVE

Yenter Pool

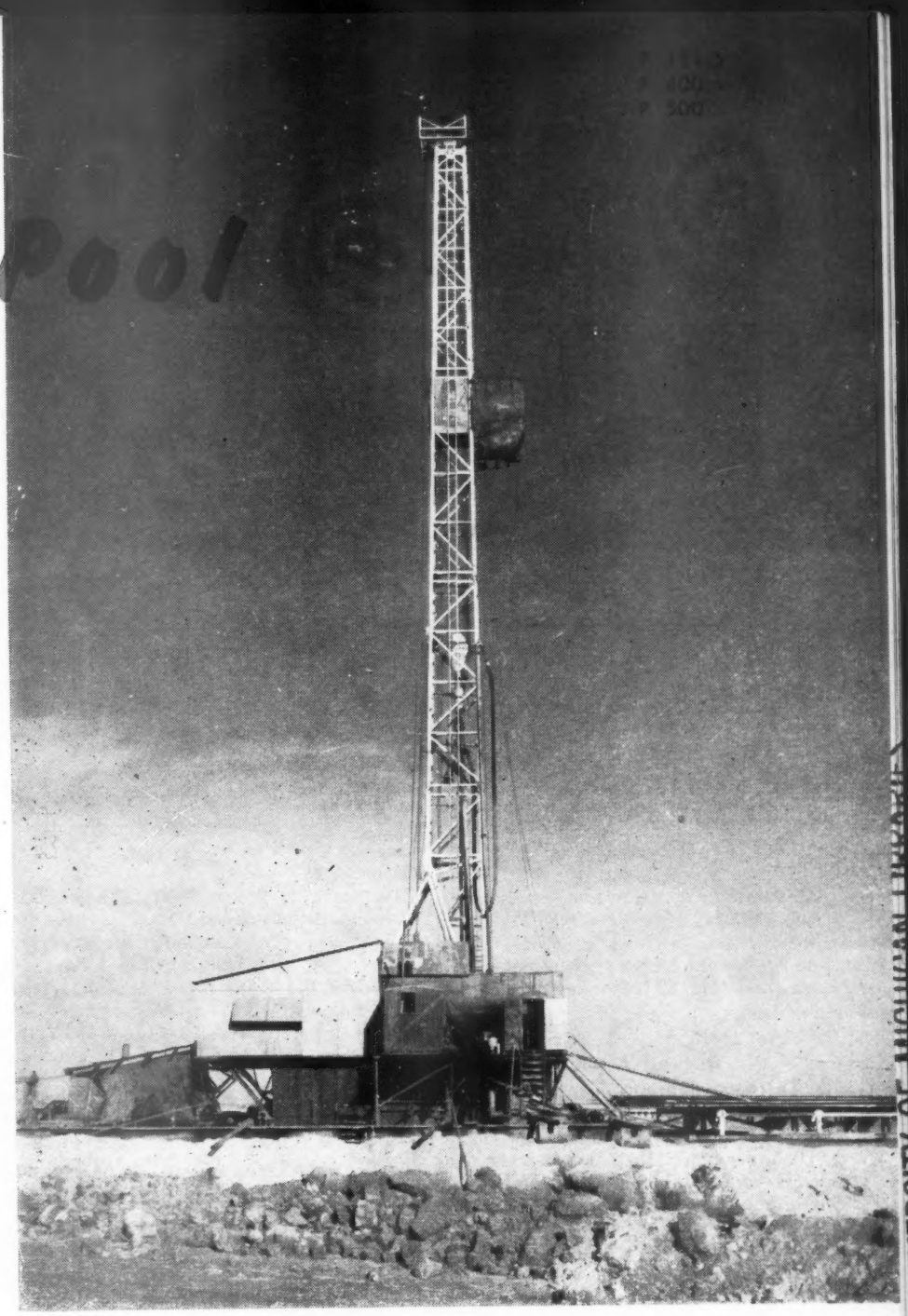
One of the large discoveries of the Denver-Julesburg Basin is in Logan County, northeastern Colorado—Here are descriptions of the drilling, completion, and producing procedures

W. K. ARBUCKLE

YENTER pool was discovered in November 1950 by the drilling of the Koenig-Ashby No. 1 well by British-American Oil Producing Company (operator) and McDermott and Barnhart. The geographic location of the pool, along with that of other Denver-Julesburg Basin pools, is shown by the map of Fig. 1. This pool has proved to be one of the largest discoveries in the Denver-Julesburg Basin play. A total of 48 producing wells, and four dry holes have been drilled to delineate the structure as thus far defined. Characterized by fast drilling and comparatively low cost, the wells being completed in the pool give indication of an early payout if pipe line restrictions are eased during the coming year by the promise of additional crude oil outlets for the Rocky Mountain area.

The field is being drilled on a diagonal 20-acre location pattern, and at this writing, covers some 1020 productive acres. Oil production is obtained at a depth of 5200 ft from the so-called "J" sand of the Granerous sand series, of Cretaceous age. A smaller gas producing horizon, the "D" sand of the Granerous series, lies approximately 100 ft above the "J" sand, but at present is not being produced for lack of an adequate gas market.

Trending northwest-southeast, the structure seemingly has been defined on all but the east and southeast extremities by dry holes. Present operations are concerned mainly with extending the pool to the southeast and drilling inside locations.



Herndon Drilling Company rigged up on the British-American L. A. Yenter B-14—this National-50 rig is typical of the size units used in drilling Yenter Pool wells.

The Author

W. K. Arbuckle is a petroleum engineer with The British-American Oil Producing Company, where he has been employed since 1949. A graduate of Texas A. and M. College with a B.S. degree in petroleum and geological engineering, Arbuckle served one year as laboratory instructor there prior to joining British American. He is a native of El Paso, Texas.

General Reservoir Characteristics

The trap that has made possible the accumulation of petroleum in the Yenter pool is of low structural relief and is characterized on the eastern flank by a permeability pinchout. The sand in most of the wells is medium-grained, uniform in character, highly porous and permeable, and sometimes heavily fractured vertically. The oil averages 39.0 API at 60 F as recovered in the stock tanks.

The oil section in the pool is relatively thin with an original gas cap above and water below. This thin section, together with highly permeable sands and vertical fracturing, has given rise to difficulties in completion techniques. By careful planning and execution of completion and remedial work, gas-oil and water-oil ratios have been effectively controlled. As in most Rocky

Denver-Julesburg Basin

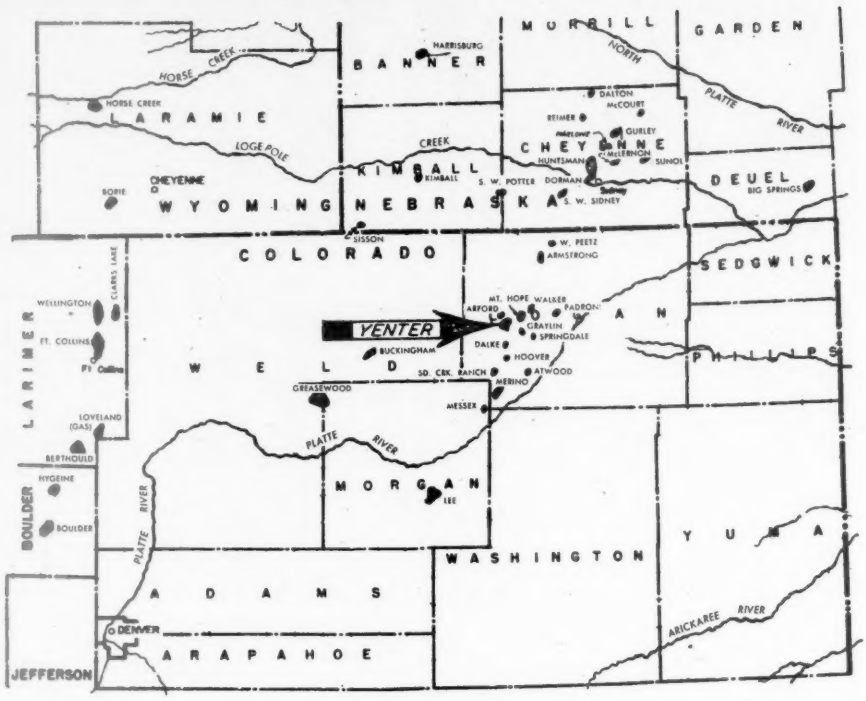
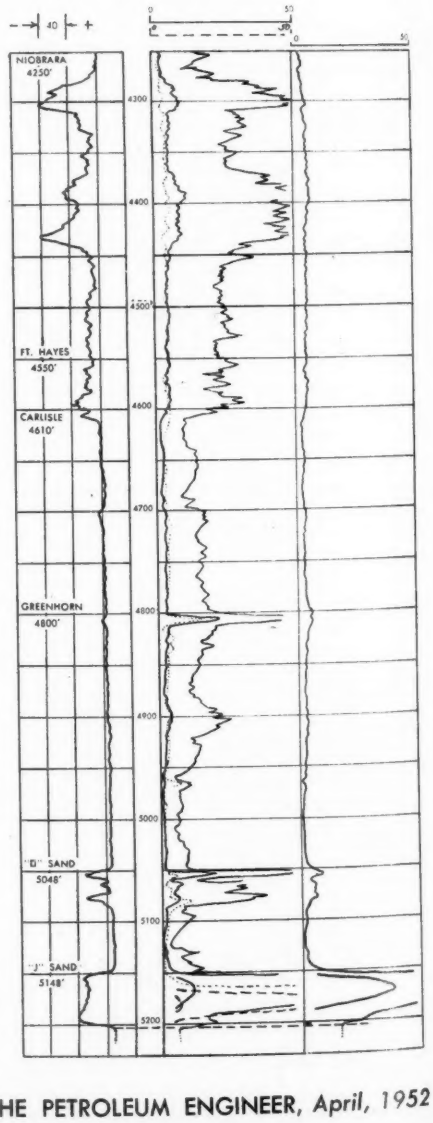


FIG. 1. Oil and gas fields of Denver-Julesburg Basin.

TABLE 1.

	Cost
Drilling:	
1. Drilling—footage rotary—5200 ft	$18,200
2. Day work—rotary	2,700
3. Day work—cable tools	1,400
4. Drilling mud and chemicals	700
5. Equipment rental (electric logs. Drill stem testing)	1,300
6. Casing (200 ft 9⅝ in. Surface Pipe and 5½ in. oil string)	11,800
7. Cement and cementing services	1,100
8. Miscellaneous costs (hauling, grading, perforating, water)	3,800
	$41,000
Producing Equipment:	
1. Pumping unit, engine, engine house	$ 7,000
2. Tubing, rods, bottom hole pump, well head equipment	7,500
3. Installation costs. (Labor, miscellaneous fittings, unit foundation)	1,600
	$16,100
Tank Battery.	
1. Tanks (Two 300 bbl welded steel)	$ 3,400
2. Heater Treater (Horizontal—6 by 14 ft)	3,500
3. Line pipe tank battery and flow line)	1,200
4. Installation costs	1,800
	$ 9,900
Total	$67,000

FIG.2 British-American Ziegler B-2, Yenter Pool, Logan County, Colorado. Perforated interval 5183-84 ft. Elevation 4334 KB. Casing, 5½ in. 15.5 lb at 5203. Total depth 5204 ft.



Mountain fields the produced water is of low salinity, near 10,000 PPM with a specific resistivity of 70 ohms/cm³ at 68 F. This fresh water accentuates problems relating to treatment of oil-water emulsions.

Drilling Practices

Drilling conditions in the Yenter pool are unusually good with respect to both time consumed and wear on equipment. The average well is drilled in seven days from under surface pipe to total depth. Four additional days are required for waiting on cement, running casing and other completion procedures. Thus, drilling of the average well requires the use of a rotary rig for about eleven days. Although a few wells were completed with rotary tools during the early stages of development, recent procedures provide for skidding the rotary rig off location 12 to 24 hr after setting the oil string of casing, and completing the well with a cable tool unit.

The formations drilled are predominantly shale to 4600 ft or the top of the Ft. Hayes lime, which is approximately 100 ft in thickness. Shale and streaks of thin lime are encountered from 4700 ft to the top of the "D' sand. (See Fig. 2) An average of six bits are used to drill these field wells to total depth.

The soft drilling minimizes crooked hole effects and very little trouble is encountered in this respect. Holes will sometimes drift as much as three degrees, but the simple expedient of reducing the drilling weight by half will bring the holes back to near vertical.

Mud Program—Very little commercial mud is used to augment the natural mud mixed in drilling the soft shales until a depth of approximately 4000 ft is reached. Below 4000 ft, a sodium-bentonite water-base mud is used to insure proper hole conditions for coring and drill stem testing. One of the mud programs used in this area is described as follows:

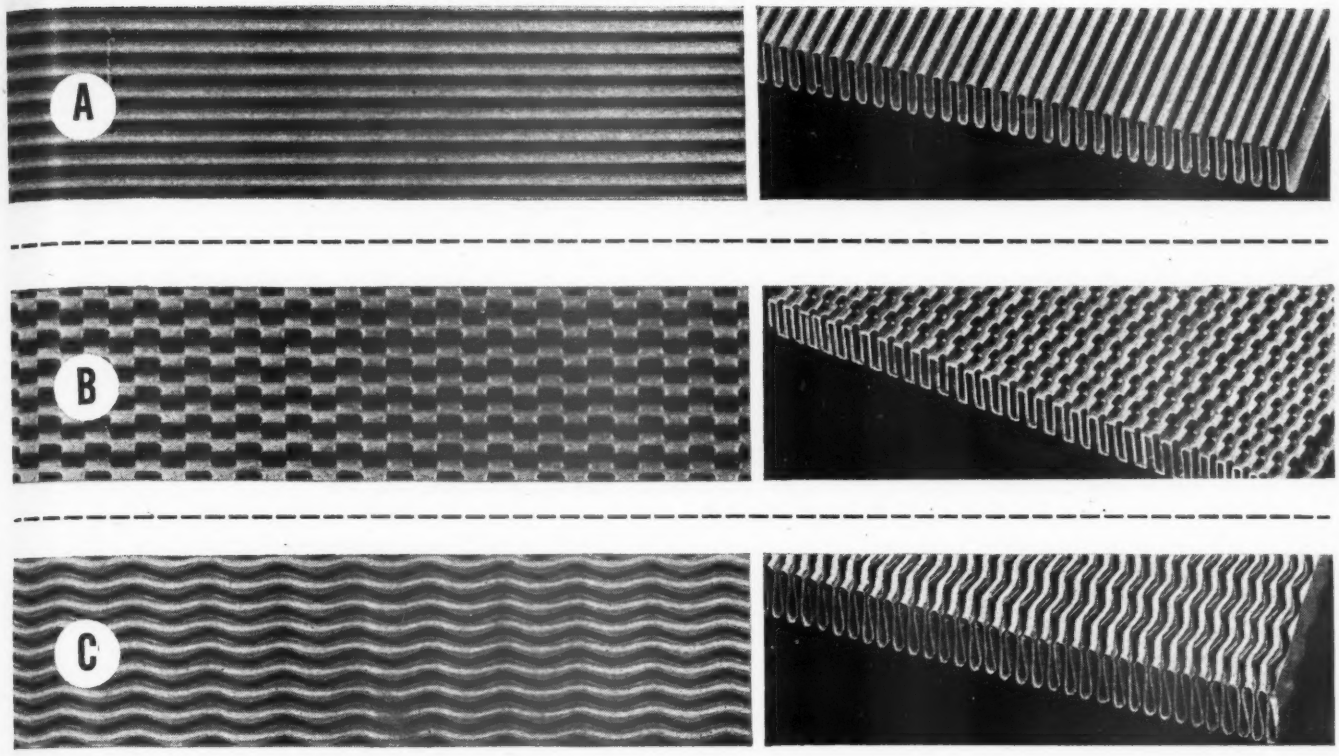
Depth Ft	*Mud Conditions*
0-4000	Fresh water natural mud. Viscosity below 50 seconds,
4000-4900	Wt. 9.8 lb per gal, Vis. 45-55 Sec. water loss 8-12 cc., PH 9, —filter cake 2/32 in,
4900-5200 TD	Wt. 9.9 lb per gal, Vis. 55-65 seconds, water loss 6-10 cc., PH 9,—filter cake 2/32 in.

Lost circulation is sometimes experienced when drilling the producing sands if the mud weight is allowed to exceed 10.5 lb per gallon. This condition is quickly remedied by replacing the mud column with newly mixed gel having a weight near 10 lb per gallon and a viscosity of 60 seconds. It is very seldom necessary to add plugging materials to regain circulation.

Considerable difficulty is encountered in drill stem testing if when drilling the Niobrara speckled shale from 4350-4500 ft the water loss is not carefully controlled. Excessive water loss in this shale may later block the passing of test tools and necessitate additional round trips through this section to condition it for testing and coring. Ordinarily, if it is possible to make several trips through the Niobrara section with drill pipe prior to drill stem testing, the hole will be in much better condition for passing test tools to total depth.

Drilling and Completion Costs

The average field well in the Yenter pool requires an expenditure of approximately $67,000. The drilling and completion costs may be itemized as shown in Table 1.



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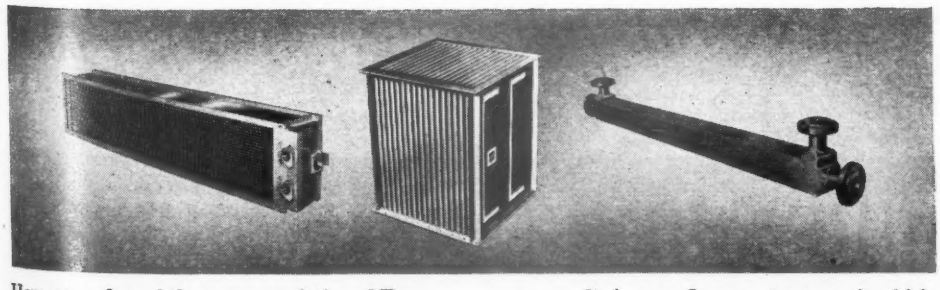
Design flexibility is but one of the many advantages of Trane Brazed Aluminum Heat Exchangers. Compared to conventional exchangers, they produce more heat transfer efficiency in ¼ the space with ⅓ the weight at approximately ½ the cost.

These all-aluminum heat exchangers are rugged, too. They take test pressures up to 1,000 pounds per square inch and temperatures from −300° to 500° F.

Whether the job calls for high or low temperatures or pressures, one stream or many, Trane Brazed Aluminum Heat Exchangers can be the answer. Contact your Trane sales office or write direct.



Here are a few of the many varieties of Trane Brazed Aluminum Heat Exchangers which are now in actual service: 1) A cross flow unit for liquid-to-gas exchange used for condensing purposes. 2) A cross flow gas-to-gas unit which is used for intercooling for aircraft engines. 3) A counter flow liquid-to-liquid exchanger for high pressure application.

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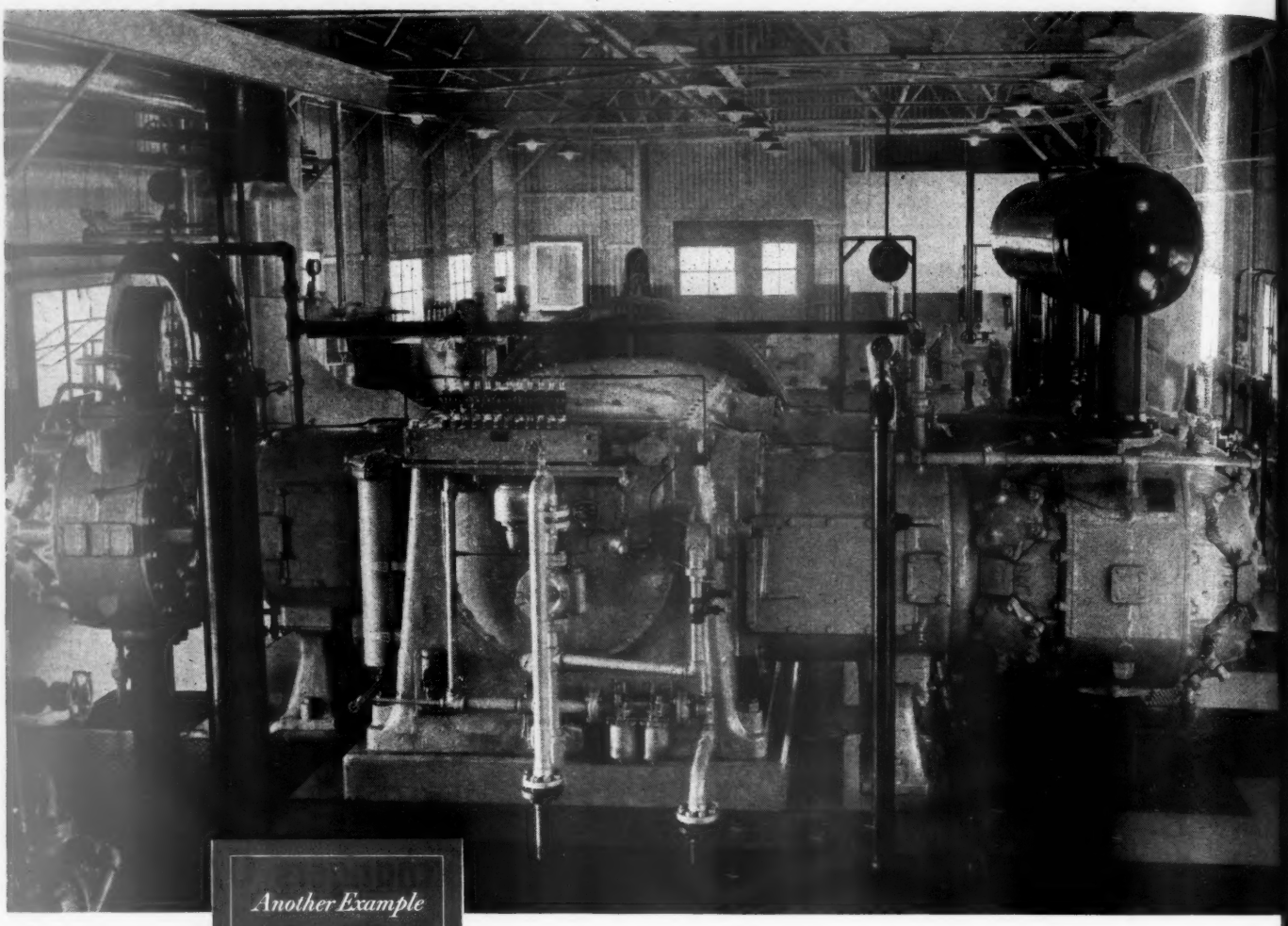

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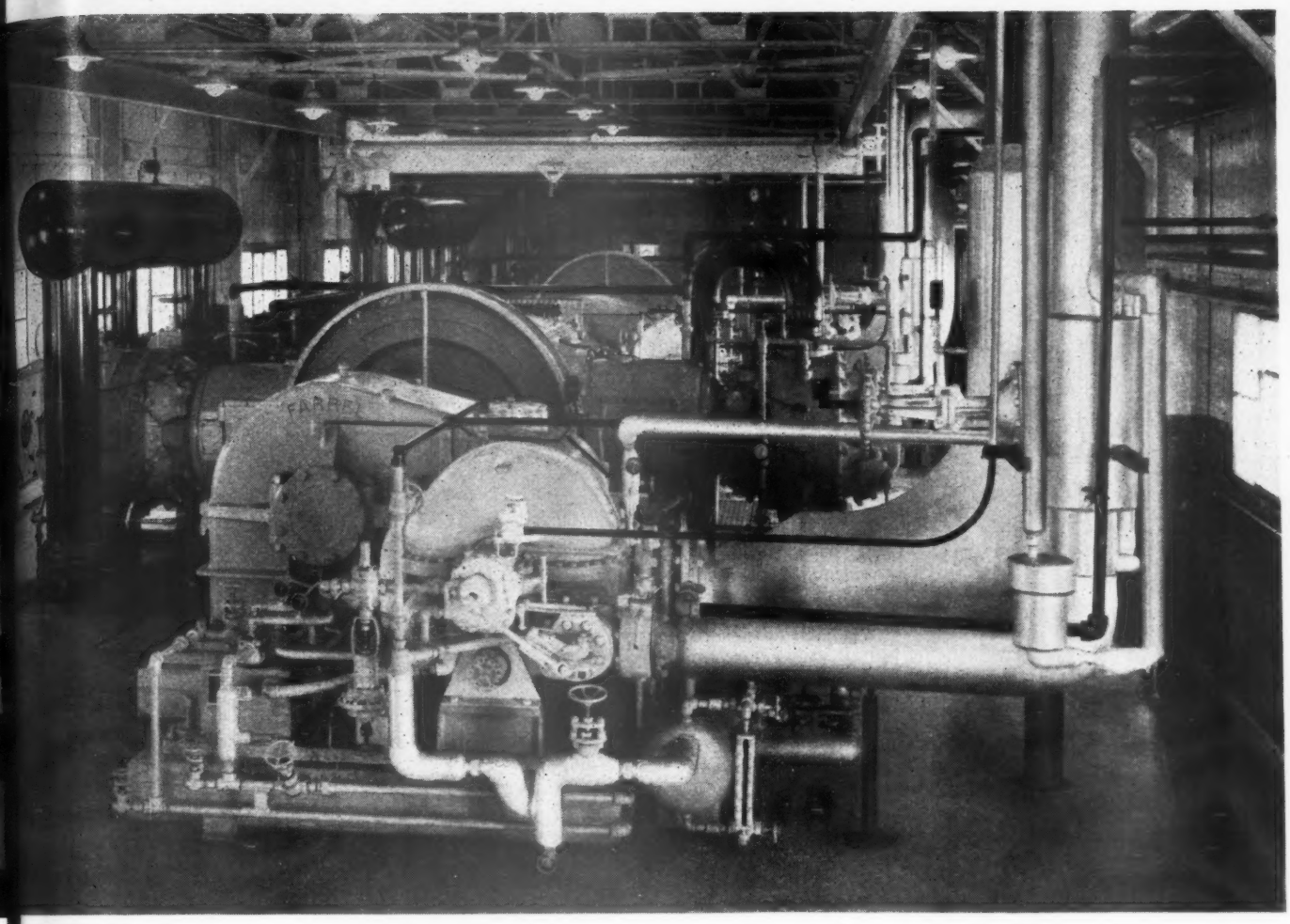

The units shown above are Cooper-Bessemer M-Line compressors in Continental Oil Company's Billings Refinery. They are turbine driven, with reduction gears, and are handling vapor and recompressor gas through 2 stages, from 17 psi to 253 psi discharge.

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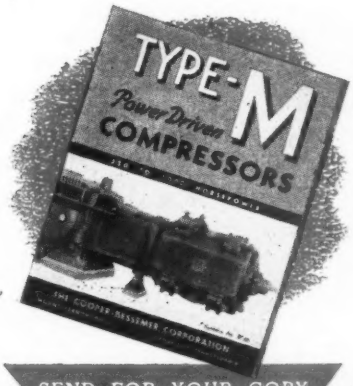
This new bulletin covers the main features of the turbine and motor driven compressor units, from 250 to 1,000 hp. It is yours for the asking.



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by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Tulsa Shreveport St. Louis Los Angeles Chicago Caracas, Venezuela

McDermott and Barnhart Knutson tank battery—Two horizontal heater treaters are housed on each side of a horizontal separator. The smaller, 6 ft by 14 ft treater on the right is used for well testing.

The total, $67,000, would represent the cost of drilling and completing the first well on a lease. Each subsequent well would not necessarily require the entire $9,900 expenditure for installation of a tank battery.

Completion Methods

Surface Pipe—Approximately 200 ft of 9⅝ in. or 10¾ in. surface pipe is set and cement circulated to ground level. Very little difficulty is experienced with surface pipe strings.

Oil String—Of the first seven wells drilled in the field, six were completed by cementing oil string casing 5 ft or more below the indicated gas-oil contact and drilling out the packer-type shoe for an open hole completion. The rather poor selectivity of producing interval afforded by this method resulted in excessive gas-oil ratios on three of the six wells, and the method was subsequently modified. All new wells now having casing set from 5 to 20 ft below the oil-water contact and are perforated through the casing for production. The oil strings are cemented with from 250 to 500 sacks of cement, both regular and slo-set being utilized. Results from perforating indicate that the primary cement jobs are effective, thus eliminating necessity of protective squeeze jobs. Centralizers and both rotating and reciprocating scratchers are successfully employed.

Completion—After cementing the long string, a cable tool unit is moved in and the pipe is swabbed and bailed dry. Gamma Ray logs may be run for measurement correlation. After partially loading the hole with oil, the well is jet perforated, usually in a one foot interval. The short perforating interval aids in the control of excessive gas-oil ratios. Present practice calls for perforating approximately one-third of the way up from the oil-water contact in the oil zone, or two-thirds of the way down from the gas-oil contact. This interval, arrived at more or less by trial and error, provides low gas-oil ratio producers without excessive rates of water production.

Four gel fracturing operations have been attempted on two different wells on the east side of the pool. The fracturing procedure was attempted as a last resort on tight shaley sections and did not produce any noticeable results in either well.

Bottom hole pressure studies taken on one of the east flank wells indicate that there is definite interference between diagonal 20-acre locations. A bottom hole pressure buildup survey indicated definite reductions in static bottom hole pressure when offset wells were placed back in service after short shut-down periods. Additional tests of this type are planned for the near future.

Producing Procedures

The operation of the entire Yenter pool is curtailed by pipe line restrictions on oil moving by truck, out of Logan County, Colorado, to the terminal of the Service Pipe Line Company at North Port, Nebraska. During bad weather when the oil trucks are unable to operate, it is sometimes necessary to shut in most of the wells in the pool. This market situation should be relieved during the coming year after completion of the Platte Pipe Line Company's new crude line to eastern markets.

Reduction of excessive gas-oil ratios is at present one of the more serious problems confronting operators in the Yenter pool. Four wells are at present shut in awaiting remedial work designed to reduce the gas-oil ratios.

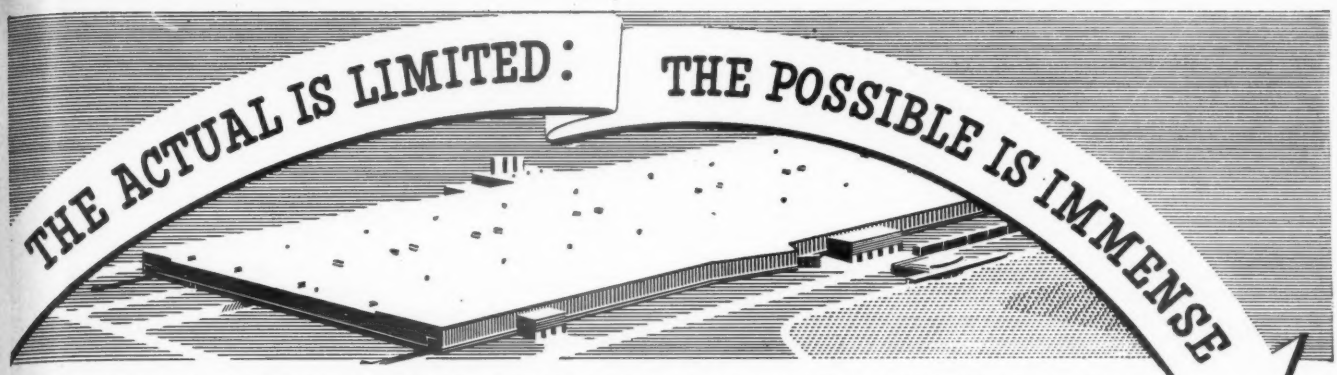
Pumping Practices—When practical, the wells in the Yenter pool are pumped. Some of the producers higher on structure are actually only agitated, but nevertheless, the pumping units are installed and operated. The bottom hole pumps are 1¾, 1½, and 1¼ in., depending upon the size of tubing and the preference of the operator. The pumping units installed are rated at 114,000 and 160,000 in. lb, maximum torque.

These large pumps and units have been purchased anticipating that eventually large volumes of water will need to be handled to recover the oil. Such will surely be the case if pressure maintenance plans include the instigation of a water injection project.

Most wells are pumped against surface chokes. The low per-well withdrawal rate, 50 bbl per day, necessitates some method of production control if the wells are to be produced continuously. The fact that some of the wells may flow intermittently requires a permanent restriction to prevent overproduction from individual wells.

Water Disposal—Produced water, which averages 40 per cent of the total fluid for the entire field, is disposed of principally by evaporation and pit seepage.

Emulsion Treating Methods—Some difficulty is experienced in treating out the relatively fresh water produced in this area of Colorado. The adverse weather conditions materially reduce the efficiency of treating on flow tanks and heater treaters, both of which are used in the Yenter pool. One emulsion-treating method employs a 400-bbl settling tank with steam coils installed in the bottom to provide heat for treating. A steam generator with capacity of one million Btu/hour is placed in separate housing away from the battery to provide steam for the flow tank and stock tanks, which also contain steam coils. All steam lines are insulated and con-



NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

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SPEEDS ERECTION...CUTS COSTS

By **Sam Bickley,**
Welding Engineer
Los Angeles, California

BY bringing their own pipe shop to the refinery, C. F. Braun & Co. greatly simplified construction problems while effecting substantial savings in time and cost. Pipespools were accurately prefabricated on the site from welding fittings, flanges and ells by working closely with construction crews. Semi-production welding methods, possible by this arrangement, permitted use of faster "Manual Lincolnwelding" of pipes to flanges. On other connections, quality pressure-type welds were produced at low cost with Lincoln's "Fleetweld* 5" and "Shield-Arc* 85", using Lincoln 300 amp. "Shield-Arc" DC motor driven welders.

*Preferred standard for electrodes on quality work.

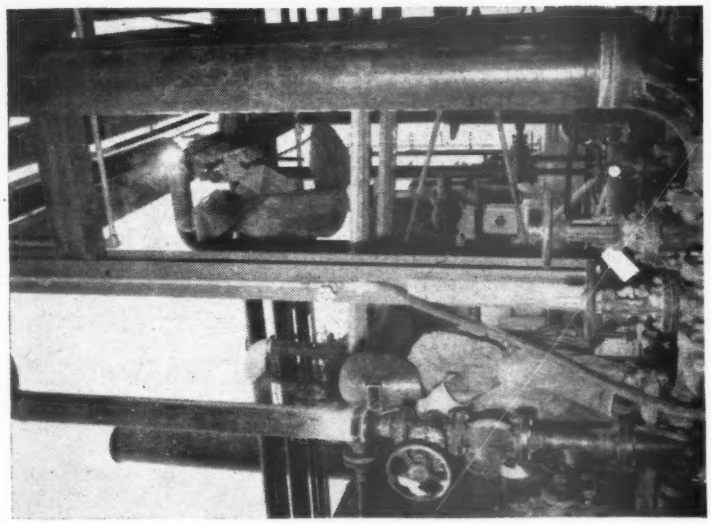

Fig. 3—"Fleetweld-Shield-Arc" Team *speeded erection of Stanocal's Oildale refinery located near Bakersfield, California.*

SIMPLIFIES FABRICATION

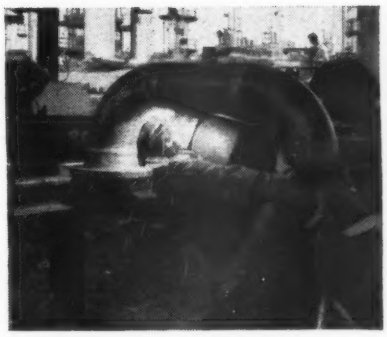

Fig. 1—Prefabricating 8" Spool *in temporary field shop, set up next to refinery, eliminated delays in getting spools to erection crews.*

SPEEDS CONSTRUCTION

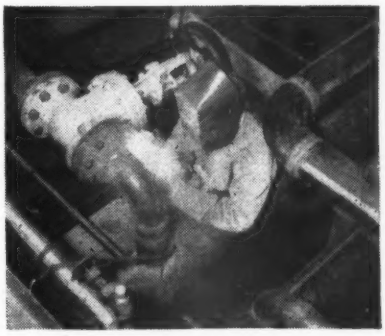

Fig. 2—Field Welding *6" flange to elbow with Lincoln "Fleetweld 5", using Lincoln "Shield-Arc" motor driven arc welders.*

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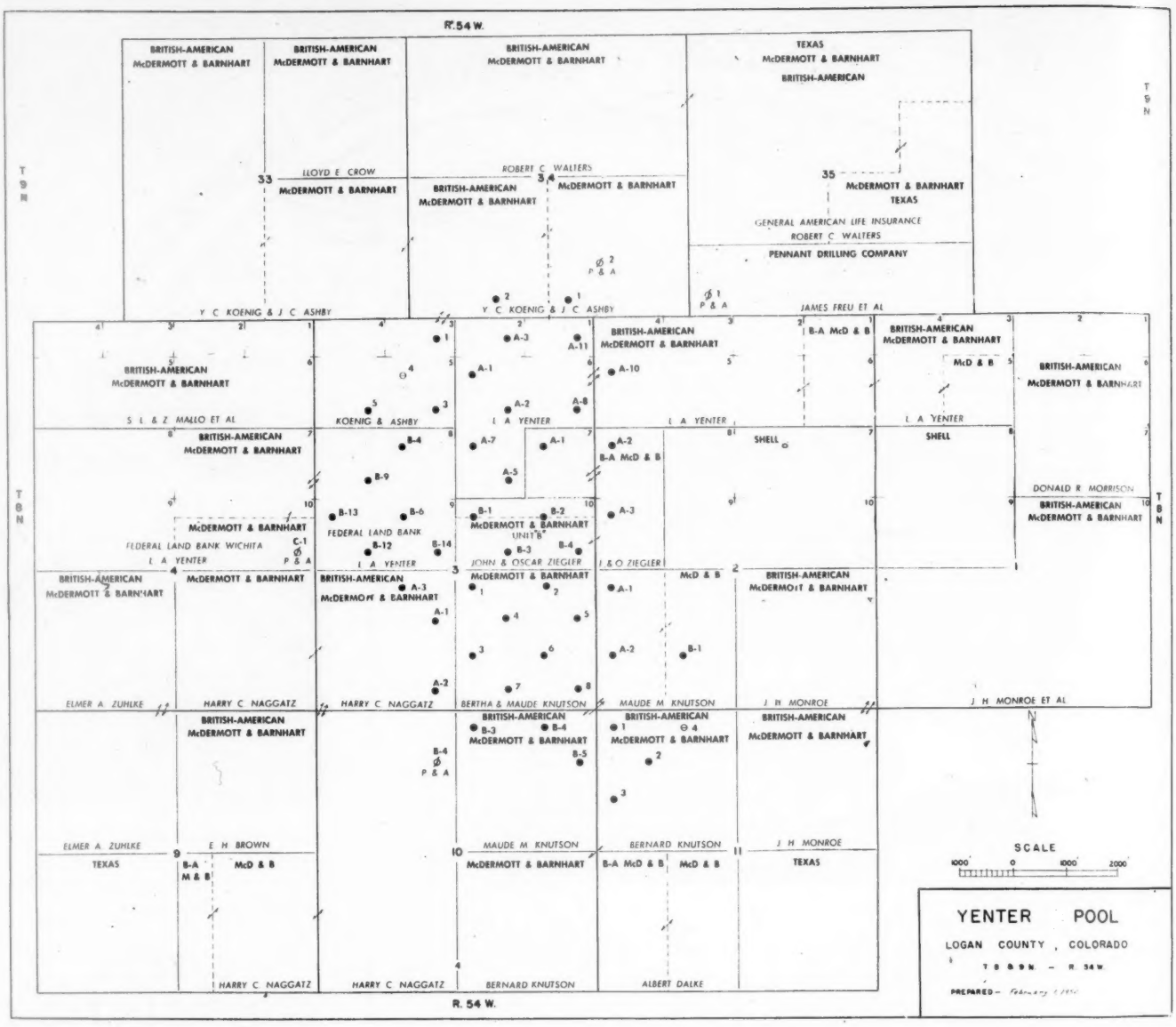


densate return lines buried 30 in. or more below ground level. This treating method has provided limited success; but when the quantity of fluid passing through the gun barrel is too great, the efficiency of treating may drop below that required by the purchaser. This then requires additional treating in the stock tanks and oftentimes proves unnecessarily expensive. The cost of the steam generator and associated system is relatively high, and for this reason on the newer batteries it has been replaced by the horizontal heater treater.

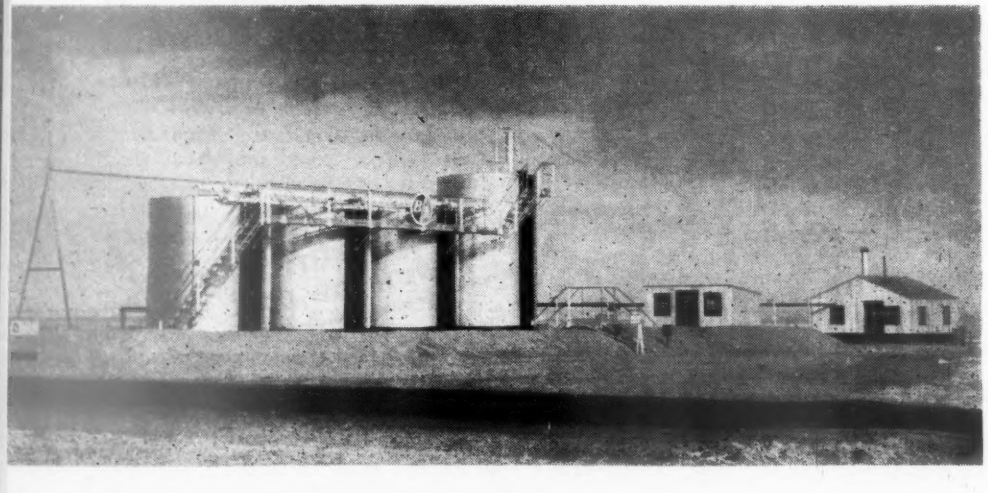
Present tank battery installations utilize horizontal heater treaters for emulsion breakdown. This method provides the most satisfactory, trouble-free operation. The heater treaters require less attention and their treating efficiency seems to be some small degree above that of the flow tanks.

Emulsion-breaking chemicals are used to aid the treating process in both types of treating systems. The chemical injectors are usually placed at the well head and may inject chemical upstream or downstream from surface chokes. Treating tests have shown that the efficiency of the treating systems may drop some 20 per cent if chemical injection is terminated.

Acknowledgment

The writer wishes to express his appreciation to the management of The British-American Oil Producing Company for permission to publish this article.

* * *



Here is shown the British-American and McDermott and Barnhart L. A. Yenter "B" tank battery. Steam generator house and separator house are shown to the right. The graded steam line passing behind the stock tanks supplies heat to the separators, flow tank, and stock tanks.

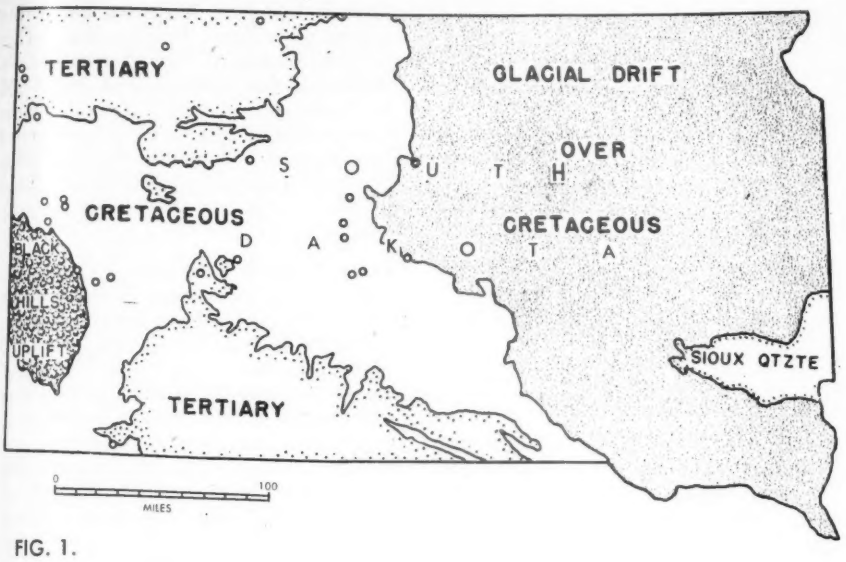


FIG. 1.

SOUTH DAKOTA

Knowledge of geology, exploration, and drilling conditions are emerging from greater activity in the southern edge of the Williston Basin

JOHN PAUL GRIES*

Williston Basin occupies parts of three states and two Canadian provinces. The southern edge, long known as the Lemmon Syncline, lies within South Dakota. About 6,000,000 acres in South Dakota are under oil and gas lease, geophysical crews are working whenever weather permits, and drilling is proceeding on several tests.

South Dakota is one of the Great Plains states; its surface is rolling farm and grass land. The monotony is broken by the Black Hills, a mountainous uplift that lies along the western edge of the state and extends into Wyoming. The greatest elevation is Harney Peak in the Black Hills, at 7242 ft; the lowest point occurs where the Missouri River leaves the southeastern corner of the state at approximately 1100 ft above sea level.

The Missouri divides the state into an "east-river" farming area and a "west-river" area of ranching and dry farming. Within the Black Hills, mining, lumbering, and tourists are important industries.

The climate is rigorous. Rainfall ranges from 16 in. on the western prairie to 30 in. along the southeast margin. Temperatures reach 25 to 30 below zero for short periods during the winter, and rise above 100 deg for similar periods during the summer. Snowfall is moderate, but the snow remains loose, and drifts badly during the colder months.

*Professor of Geological Engineering, South Dakota School of Mines and Technology, Rapid City, South Dakota.

Geology

Surface Geology. Fig. 1 outlines the principal geologic units within the state. East of the Missouri River, a mantle of glacial drift averaging 60 ft in thickness, covers the surface. Bedrock is weak, gray marine shale of late Cretaceous age, except for an area of Precambrian quartzite in the southeast part. Most of the land east of the river is farmed, and is owned in fee.

West of the river, four units are recognizable. The Black Hills comprise an area about 60 miles east-west and 100 miles north-south. The uplift is an elongate dome, and the steeply upturned edges of older rocks form concentric ridges and valleys. Since their uplift, approximately 10,000 ft of sediments have been removed by erosion. Oil prospects are limited to a few well drilled anticlines around the margins. Much of the land is held by the Federal and state governments.

Surrounding the hills, and extending across the central part of the state, is an outcrop area of Cretaceous shales. On the upland surfaces, the shale may be overlain by a few feet of gravel, but for the most part it is eroded to gently rolling shale hills. Extensive breaks, with up to 500 ft of relief, are developed along the Missouri and Cheyenne rivers. The shales weather to gumbo, and make travel very difficult during the spring thaw and after summer rains. Much of the land was homesteaded between 1904 and 1917, and is privately owned.

The south central part of South Dakota, labelled Tertiary in Fig. 1, varies from rolling, grass-covered sandhills to the starkly spectacular Big Badlands. Most of the land is federally held, for Indian reservations, Badlands National Monument, and Air Force bombing ranges.

The fourth area lies in the northwest and north central part of the state, over the deeper portion of the Lemmon syncline. Although labelled Tertiary on the map, it is drawn to include the uppermost Cretaceous Fox Hills and Hell Creek formations. These consist of sandstone, dark somber clays and some lignites. A maximum of 1000 ft of nonmarine sediments is probably present along the state line in Corson and Perkins counties. The surface is gently rolling rangeland, with some dry farming. Some of the land is owned in fee, but there is much state and federal land.

Structure

The structural features of the state may be seen in Fig. 2. The contours are drawn on the top of the Dakota sandstone, to which at least 2000 artesian wells have been drilled. Although this is the most convenient datum, it is not entirely satisfactory, for the "Dakota" sand lies at least 500 ft higher stratigraphically in eastern South Dakota than it does around the Black Hills. If this were one smooth surface, on top of a transgressive sand becoming younger to the east, the result would merely tilt the structure map, but unfortunately, a series of sands, extending irregularly from the east, and interfingering with shales from the west, gives a group of highly variable points for the elevation of what the water-well drillers have called the first water-sand. The 500-ft contour interval more or less smoothes out the inconsistencies, but of course obliterates any small structures at the same time.

Because of the addition of a few thousand feet of additional Paleozoic section in the deeper part of the basin, contours drawn on the top of the Precambrian would be much more strongly downwarped.

Stratigraphy

The stratigraphy of the area has been described in detail in several of the recent references at the end of this article, and will only be summarized briefly in this paper.

EXCLUSIVE

Williston Basin

Paleozoic Era

Cambrian System

Deadwood formation. The Deadwood formation is named for its type locality at Deadwood, South Dakota. Outcrops vary in thickness from about 450 ft near the type area to as little as 4 ft in the Southern Black Hills. The thickness in subsurface in the northwestern part of the state is probably less than 300 ft. It thins to the east by non-deposition or erosion, and is missing before the Missouri River is reached. At the type locality, the formation is divisible into a basal conglomerate and quartzite, a thick medial member of shaly, glauconitic dolomite with interbedded sandstones, shales, and edgewise conglomerate, and an upper 100 ft of glauconitic sandstone. Much of the green shale that was formerly assigned to the Deadwood in subsurface in the Williston Basin is now placed in the Ordovician.

Ordovician System

In the northern Black Hills, 145 ft of section is now assigned to the Ordovician. The lower 85 ft, consisting of green shale, siltstone and sandstone, was formerly considered part of the Deadwood, but is now known to be of Black River age.

The upper Ordovician Whitewood dolomite in the northern hills thickens to the north in subsurface, and is in turn overlain by the higher Ordovician Bighorn dolomite. The total Ordovician section reaches a thickness of 1250 ft or more in the northwest corner of the state. Its southern and eastern limits may be seen in Fig. 3.

Silurian and Devonian Systems

No Silurian or Devonian crops out in the Black Hills. It is not recognized as subsurface in the northwestern part of the state. Reports of Silurian limestone in the recent Shell No. 1 Homme test in Perkins County is the first evidence that it extends into the South Dakota part of the Basin. The maximum area over which it may be anticipated is shown in Fig. 3.

Devonian in the Williston Basin can be divided into four formations, each of which can be seen on the surface near Winnipeg, Manitoba. Devonian is tentatively identified in the Shell tests in Perkins and Corson counties, as indicated on Fig. 3. The areal distribution of each of the pre-Mississippian formations is indicated in the same figure. To what extent these boundaries represent original extent of deposition, and to what extent they represent one or more periods of erosion is not yet known.

Mississippian System

Madison Group. In the Black Hills, a thin, pink, basal limestone, called the Englewood, is correlated with the Paine member of the Lodgepole formation of the Madison Group in Montana. Overlying the Englewood is the Pahasapa, which consists of outcrops of 300 to 660 ft of medium crystalline, light gray to buff limestone and dolomite. The formation thickens to the north, and thins out to nothing against the Precambrian across the south central part of the state. To the east, it wedges out a short distance east of the Missouri. The Pahasapa is porous and cavernous, and carries water wherever encountered.

Big Snowy Group. The Big Snowy does not crop out in the Black Hills, and is present in subsurface only in the northwestern corner of the state. The lowest member, the Charles, is most widespread. It consists of dolomite and anhydrite, and is similar to the underlying Pahasapa.

Amsden formation. The Amsden is a Wyoming and Montana formation. It extends into the Williston Basin, but if present in South Dakota, it underlies only the northern tier of counties. In North Dakota it consists of up to 250 ft of orange, red, and purple dolomitic limestone and shale. It is overlapped from the south by the similar appearing Minnelusa formation; relations between the two have not been satisfactorily worked out.

Pennsylvanian System

Minnelusa formation. At its type section on the east side of the Black Hills, the Minnelusa formation consists of 560 ft of limestone, dolomite, sandstone, and shale. Anhydrite is conspicuous in subsurface. Its absence on the outcrop is usually assigned to solution, but recent lithofacies studies suggest that clastics were deposited over the site of the Black Hills simultaneously with the precipitation of evaporites in the adjacent areas. The formation varies in thickness from 1200 ft in the extreme southwestern corner, to a probable 300 ft in the northwest corner of the state. To the east, it thins rapidly by overlap and erosion, and is missing a short distance east of the Missouri River.

Permo-Triassic Systems

The redbed section is made up of the Opeche, Minnekahta, and Spearfish formations. The Opeche consists of 100 to 150 ft of red shale, the Minnekahta of 50 ft of thin-bedded purplish limestone, and the Spearfish of typical redbeds. The combined series has a total thickness of about 500 ft in western South Dakota, and reaches a maximum thickness of nearly 1000 ft in western North Dakota. The group wedges out before the Missouri River is reached. The Opeche and Minnekahta are believed to be Permian, the upper Spearfish, at least, is considered to be Triassic.

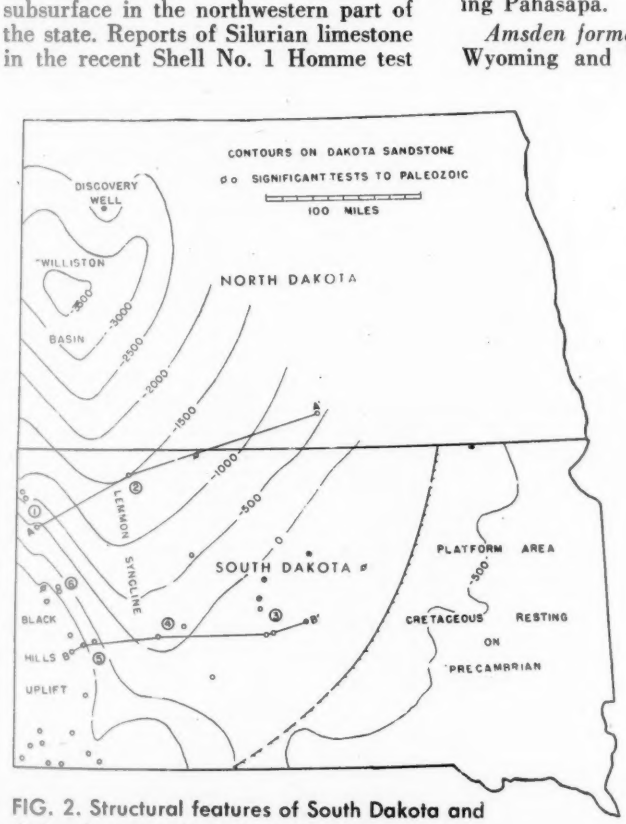


FIG. 2. Structural features of South Dakota and their relation to the Williston Basin.

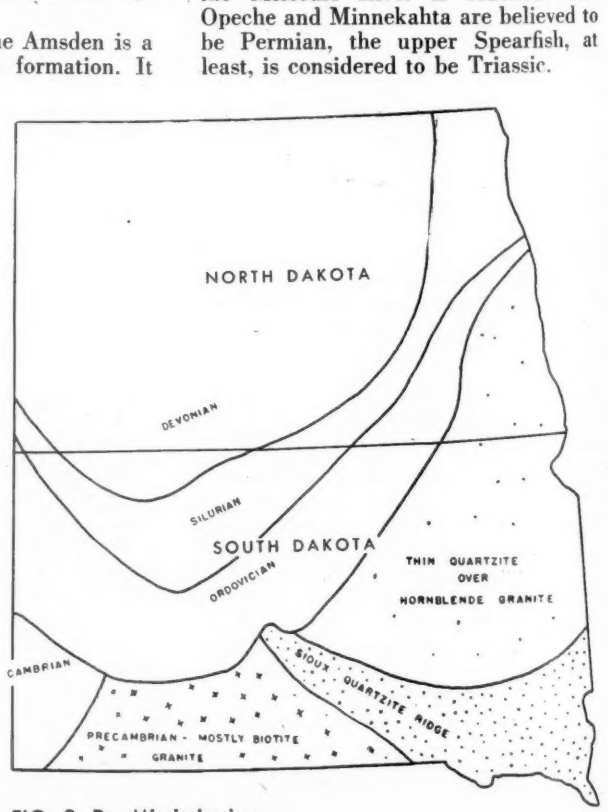


FIG. 3. Pre-Mississippian paleogeologic map.

TABLE 1. Significant pre-Dakota wells in West Central South Dakota.

Name	Location	Comp.	Elev.	T.D.	Formations tested	Samples	Electric log
Butte County							
R. P. Harmon Assoc. No. 1 Wm. Olson	27 T9N R3E	1951	3050	3240	Graneros-Pahasapa	yes	no
Wm. Seyler No. 1 Gov't-Anderson	12 T8N R5E	1949	2887	5759	Pierre-Deadwood	yes	yes
U.S.D.S. Exp. Sta. Water well	24 T9N R5E	1935	2874	4400	Pierre-Minnelusa	yes	no
Corson County							
Shell No. 1 Winters	11 T22N R19E	1952	Drilling				
Haakon County							
F. E. Pohle Enterprise No. 1 Sch. Land	16 T4N R18E	1951	2497gnd	4743	Pierre-Pahasapa	yes	yes
Harding County							
Northern Ordnance No. 1 Gov't (Gustav)	32 T15N R2E	1944	3322gnd	7038	Fox Hills-Ordovician	yes	yes
Northern Ordnance No. 1 Sch. Land	1 T17N R1E	1943	3430DF	7998	Hell Creek-Ordovician	yes	yes
States Royalty Petroleum Co	35 T18N R1E	1940	3268	7908	Hell Creek-Ordovician	yes	?
Hughes County							
Pierre Airport water well	35 T111N R79W	1942	1719KB	2370	Pierre-Ordovician (?)	yes	?
Hyde County							
N. B. Hunt No. 1 School Land	24 T116N R73W	Drilling					
Lawrence County							
F. J. Weller No. 1 Weisman	30 T7N R4E	1950	3680	3143	Dakota-Deadwood	yes	?
Meade County							
Morton No. 1 Olson	35 T2N R9E	1950	2934	4205	Pierre-Minnelusa	yes	yes
John C. Arp No. 1 Gingras	19 T3N R7E	1942	—	1250	Sundance-Minnelusa	yes	no
Kucera No. 1 Gingras	19 T3N R7E	1949	3600	1368	Sundance-Minnelusa	yes	?
Kucera No. 2 Gingras	19 T3N T7E	1950	3665	2153	Sundance-Deadwood	yes	?
Pennington County							
Gypsy No. 1 Hunter	28 T3N R16E	1931	2957	5001	Pierre-Pahasapa (?)	yes	no
Rapid City No. 1 Airport water well	18 T2N R9E	1942	3192DF	4645	Pierre-Englewood	yes	yes
Rapid City No. 2 Airport water well	13 T2N R8E	1942	3210	4436	Pierre-Pahasapa	yes	yes
City of Rapid City water well No. 1	9 T1N R7E	1935	3359	1460	Spearfish-Precambrian	yes	no
Perkins County							
Shell No. 1 Homme	13 T20N R12E	1951	2766DF	9345	Ft. Union-Precambrian	yes	yes
Potter County							
Carter No. 1 Stratigraphic test	34 T118N R78W	1940	1865DF	3615	Pierre-Precambrian	yes	yes
Shannon County							
Amerada No. 1 Red Eagle	25 T36N R48W	1945	3344	3367	Niobrara-Precambrian	yes	yes
Stanley County							
S.D. Dev. & Ref. Co (Standing Butte)	9 T7N R27E	1922	1958	3508	Pierre-Pahasapa	yes	no
Carter No. 2 Stratigraphic test	12 T9N R27E	1940	1786	3885	Pierre-Precambrian	yes	yes
Phillips No. 1 State School Land	36 T5N R27E	1944	1854	2767	Pierre-Precambrian	yes	yes
Phillips No. 1 Lang	26 T5N R28E	1944	1982DF	2435	Pierre-Precambrian	yes	yes
Phillips No. 1 Dakota	16 T6N R27E	1945	2186	4202	Pierre-Precambrian	yes	yes
Ziebach County							
Cosden No. 1 Ole Tanberg (Red Elm)	9 T11N R19E	1930	2328	3581	Fox Hills-Spearfish	yes	no

Mesozoic

Jurassic System

Jurassic sediments are widespread in the Williston Basin, extending east over the truncated edges of all earlier formations. The series ranges up to 900 ft on the outcrop southeast of the Black Hills, but averages less than 500 ft in subsurface. Although the Nugget (?), Gypsum Springs, Sundance, Unkpapa, and Morrison are all recognized on the outcrop, only the Sundance and Morrison are generally identified within the South Dakota part of the Basin.

Cretaceous System

The Cretaceous sediments in South Dakota start with a lower series of sands, the Lakota, Fuson and Dakota formations, which are called the Cloverly Group farther west. The total thickness of this interval averages 300 ft. There follows a series of gray marine shales, with thin limestones and sandstones, reaching a maximum thickness within the state of about 3250 ft. Deposition of the Fox Hills sandstone, whose thickness averages 100 ft or less, closed marine sedimentation. Continental deposition of nearly 400 ft of non-marine clays and sands of the Hell Creek formation brought the Mesozoic Era to a close.

Tertiary

In the northwestern part of the state, the Paleocene is represented by the Ludlow, Cannonball, and Fort Union formations. The Ludlow consists of up to 350 ft of light colored sandstones and clays with numerous important lignite beds. The Cannonball marine member consists of sandy green shales which extend into the state from the northeast, and grade laterally into the Ludlow. The Fort Union is represented by up to 300 ft of light colored sandstone and shale, but it has a very limited distribution along the northern border of South Dakota. Isolated high buttes in Harding County are capped with sandstones of Oligocene (White River) and Miocene (Arikaree) beds. The White River has a local thickness of 160 ft; the Arikaree varies from 75 to 225 ft.

In the south central part of the state there is no Paliocene or Eocene. Oligocene clays of the Chadron and Brule formations have a total thickness of up to 600 ft, and lie directly on the Pierre shale. To the south, the Miocene Pine Ridge escarpment is composed of up to 500 ft of clay, sand, and volcanic ash. These are in turn overlain by Upper Miocene and Pliocene beds called the Ogallala Group, consisting of up to 350 ft of tuffaceous sand and clay. Thin Quaternary sands cover the surface in some areas adjacent to Nebraska line.

Exploration

History. Since the first test in 1904, about 75 oil tests have been started in South Dakota. Many of them were drilled on shallow structures near the Black Hills, and contributed nothing to our knowledge of the Williston Basin. Others, lying within the Basin, failed to penetrate the full Cretaceous section. Table I summarizes the results of all significant pre-Dakota wells in west-central South Dakota. It is complete, except for Fall River and Custer counties south of the Hills, a few wells started below the Dakota within the the Black Hills uplift, and a few tests in the east-river area where Sundance, Paleozoics or Precambrian have been encountered

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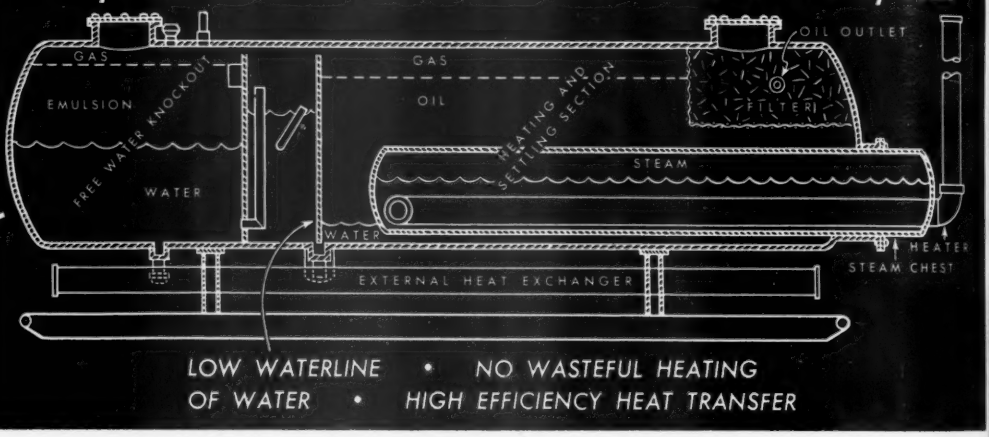

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Williston Basin

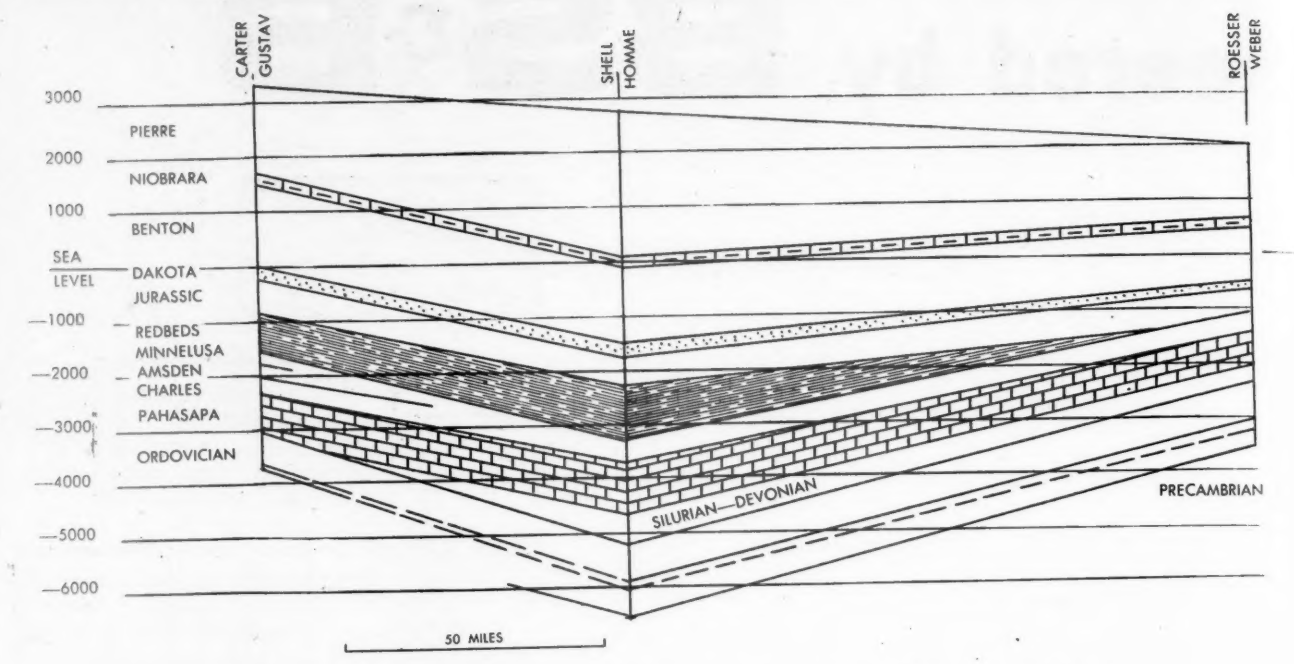

FIG. 4. Southwest-northeast cross section through Williston Basin from Harding County, South Dakota to Emmons County, North Dakota. Section A-A on Fig. 2.

beneath the Dakota Group at relatively shallow depths.

A glance at Fig. 2 indicates that these tests are grouped into definite areas, which are numbered to correspond with the following paragraphs.

1. *Harding County.* Several small *en-eschelon* folds occur in the southwestern part of the county. They are probably related to the much larger Cedar Creek anticline, which extends into the northwest corner of the county from Montana. The largest of these, the Camp Crook anticline, was tested to the Ordovician by the States Royalty Petroleum Company in 1939-40. A good show was encountered in the Middle Ordovician sandstone. Northern Ordnance drilled a short distance southeast in 1943, and farther south on the Gustav structure in 1944. All these tests showed, in addition to the Black Hills section, an upper Mississippian Big Snowy section, and a greatly increased thickness of upper Ordovician limestone and dolomite.

2. *Lemmon Syncline.* The Shell No. 1 Homme in Perkins County bottomed at 9345 in granite. It is the deepest test to date in the state, and suggests that the deepest hole will not exceed 10,000 ft in the South Dakota part of the Basin. As mentioned previously, this test first proved the presence of Silurian and Devonian within the state. A second test, slightly higher structurally, is now being drilled to the east in Corson County.

3. *Central South Dakota.* The Standing Butte test was drilled in the early 1920's on the basis of surface mapping and the presence of dry gas in nearby artesian wells. The well reached the Pahasapa limestone, but the record was misinterpreted until Carter drilled two surface and seismic highs in the area in 1940. These permitted proper interpretation of the pre-Jurassic pinchouts. A deep water well at the Pierre Airport in 1942 showed a similar section east of the river. The Phillips Petroleum Company drilled three stratigraphic tests in southern Stanley County in 1944-45. As can be noted on Fig. 5, these tests straddled the pinchout of Ordovician and Mississippian beds against a Precambrian quartzite ridge.

4. *West-Central South Dakota.* The Gypsy Oil Company drilled a 5001-ft test in eastern South Dakota in 1931. Unfortunately the test stopped in beds that are probably Mississippian. Last year, F. E. Pohle and associates drilled the so-called Ash Creek structure, mapped by Charles Lupton in 1922 and 1930. A twistoff at 4743 ft, in the Pahasapa, finally caused the hole to be abandoned with 2100 ft of drill pipe still in

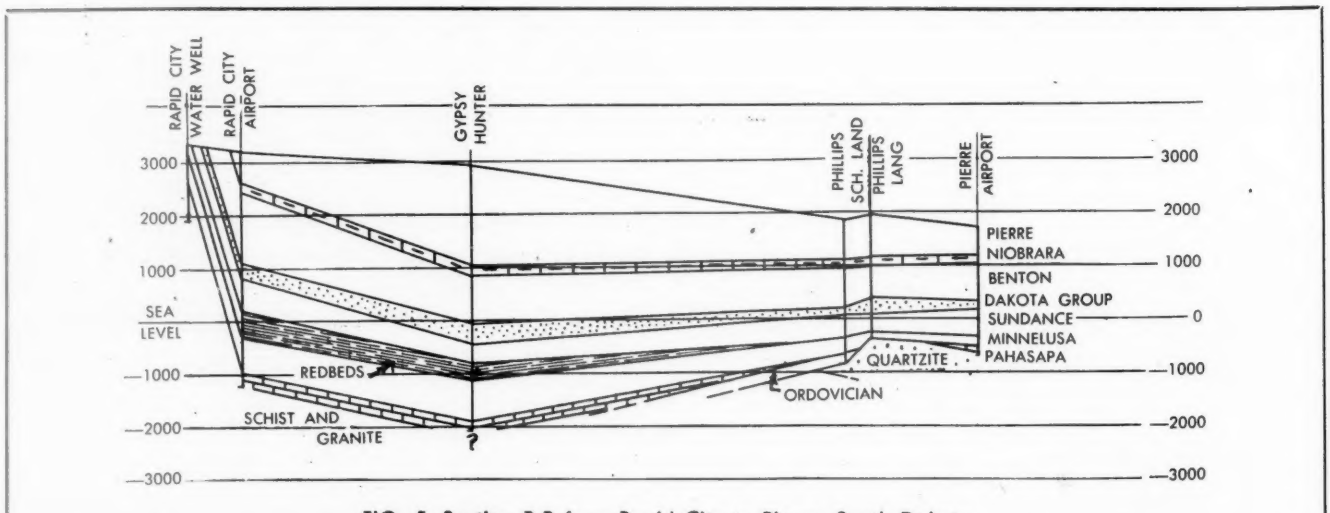

FIG. 5. Section B-B from Rapid City to Pierre, South Dakota.

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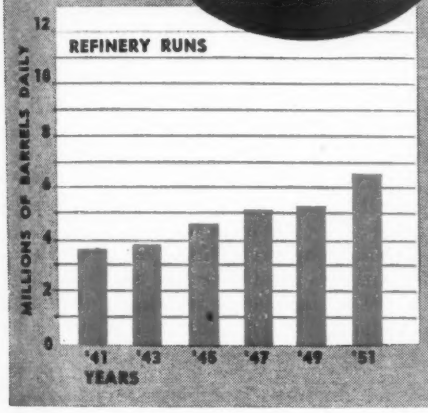

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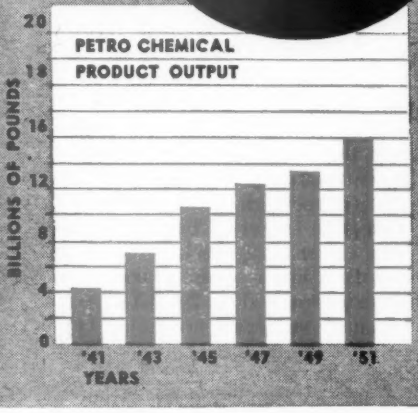

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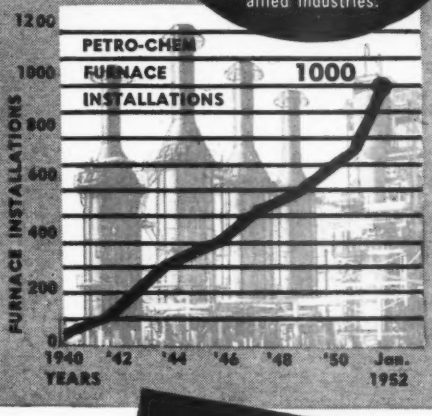

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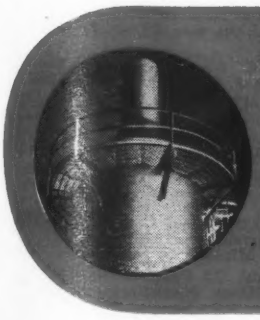

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the hole. The test bottomed in Mississippian, and the electric log goes only to the top of the fish.

5. *East of the Black Hills.* Deep water wells, and one oil test, show sections very similar to the outcrop. Numerous shallow tests, usually to the Newcastle (Muddy) sandstone, have been put down in this area. To the north, tests on a sharp anticline at Piedmont, Meade County, have yielded oil shows but no production.

6. *North of the Hills.* The two westerly tests are drilled on possible closures on the north-plunging Whitewood anticline. The hole to the northeast is a water well, and the southeast test was drilled to the Cambrian on a geophysical prospect.

Oil Possibilities

Up until two years ago, the only encouraging oil shows within the Williston Basin were the numerous shows in the Madison along the Cedar Creek anticline in southeastern Montana, and the Ordovician sandstone show in the States Royalty Petroleum Company well on the Camp Crook anticline in Harding County, South Dakota. But since then, Madison production has been developed on the Nesson anticline in North Dakota, and good Madison shows have been encountered as far east as Manitoba. The Shell Oil Company No. 1 N. P. R. R. (Richey) well in Dawson County, Montana, is probably producing from the Charles formation of the Big Snowy Group. Devonian zones are productive on the Nesson anticline. And in The Texas Company No. 1. N.P.R.R. near Glendive, and the Shell-Continental No. 1 Pine Unit wells in the Cedar Creek anticline area of southeastern Montana, productive beds are probably Upper Ordovician, though they are being variously correlated as Upper Ordovician, Silurian, and "lower" Devonian. It has thus been shown that at least five separate zones may carry oil when conditions are proper within Williston Basin.

The geology is not yet well known in the deeper parts of the Basin. Only the most obvious surface highs have been drilled. The geophysical picture is far from complete. Not enough is known about facies changes within these formations to know where porosity and permeability may be developed. Many stratigraphic possibilities cannot be determined until more drilling is done. It is evident, however, that many formations pinch out up dip around the southern margin of the Williston Basin within South Dakota. The nature and general location of several of these pinchouts is suggested in the accompanying maps and cross-sections.

Drilling Considerations

Road restrictions. Most South Dakota roads are gravel surfaced earth roads. Others are blacktop, on a light gravel base. None are built for heavy duty, and all become very soft during the spring thaw. Stringent load restrictions are applied during that time, and they are very diligently enforced. The higher limits and more lax enforcement in adjacent states essentially means dividing heavy loads at the South Dakota line.

Drilling water. The situation is similar to that encountered in Montana or Wyoming. Sources are stock dams or permanent streams for surface water, and deep wells for artesian water. It is seldom feasible to drill a water well at the drill site. Some of the waters give trouble in cementing operations.

Ground water. Ground water is one of the most valuable assets of the state, and every effort must be made to safeguard it.

Because there is very little shallow water in South Dakota, a minimum of surface pipe has generally been used. Water conditions are different in the general areas outlined in Fig. 1, and are here considered separately.

East of the Missouri, as already mentioned, the glacial drift is usually less than 60 ft thick, though up to 200 ft has been reported. In many areas it is so dense that even domestic supplies cannot be obtained from it. Through much of the east-river area, dependence is upon artesian wells ranging from 700 to 1500 ft in depth. The flow from the Dakota-Lakota group is moderate, and gives no trouble in rotary drilling. Recently, east of the river in Hyde County, artesian water under excessive pressure has been encountered in the Sundance sands. A recent well was lost when heavy flows from 2400 ft broke around the outside of surface pipe.

In central South Dakota, shale forms the surface rock; there is no surface water except in the river bottoms. Ranchers rely either upon stock dams or artesian wells. Depth to the Dakota sandstone varies from 600 to 2000 ft. Artesian water under moderate head may be anticipated in the Dakota sands, and in the Pahasapa limestone. Very little has been found in the Sundance or Minnelusa formations except very close to the Black Hills, where high heads at shallow depths may give trouble.

In the northwestern part of the state, sands occur through the non-marine upper Cretaceous and Tertiary sections. The most reliable aquifers are in the Fox Hills and basal Hell Creek sandstones. Ranchers depend on these sands throughout the area, at depths ranging from a few tens of feet around the margins to over 900 ft in the vicinity of Lemmon.

Water conditions vary widely in the Tertiary area in the south central part of the state. In the part closest to the Black Hills, Oligocene clays overlie Pierre shale. There are no shallow sands; water supply must come from the surface or from artesian wells to the Dakota sand. No heavy artesian flows should be anticipated. The rest of the area is underlain by Miocene sandstones which yield abundant water at depths up to a few hundred feet.

In the Black Hills area, steeply dipping beds cause conditions to vary rapidly from place to place. Drilling within the Hills proper is limited to water supply work.

Lost circulation. With proper mud, little trouble is encountered with lost circulation in any of the sandstone sections. The 50-ft Minnekahta limestone often gives trouble in badly fractured areas close to the Black Hills. The upper 100 to 150 ft of the Pahasapa is very porous, and is locally cavernous. This condition apparently occurs throughout the northwestern half of the state.

Materials to be drilled. Formations are essentially the same as those encountered in Montana, Wyoming, and North Dakota. A large footage in any well will consist of the soft, mud-making Cretaceous shales. The Dakota-Lakota sandstone section drills easily except for local "caps" of pyrite-cemented sandstone. The most abrasive rocks are usually the sandy dolomites and anhydrites of the Minnelusa formation. No heavy chert sections are known. Anhydrite occurs in the Minnelusa, Big Snowy, and Devonian sections. No salt has been encountered, and none is anticipated within the South Dakota portion of the Williston Basin.

Records. Drilling records, samples, electric logs, etc., must be filed with the state geologist at Vermillion. Upon request, these will be held confidential for six months before being placed upon public file. Much of this material is also available at the School of Mines and Technology at Rapid City. The school is also a repository for many sample sets from wells in adjacent parts of Nebraska, Wyoming, Montana, and North Dakota. Lists of samples are available for study from both institutions.

Rules and regulations. An oil and gas board was established in South Dakota in 1943; legislation regulating drilling, producing, and plugging was also passed at that time. Regulations relating to certain slim hole stratigraphic tests were modified in the 1951 session of the legislature. Enforcement of the laws and regulations is supervised by the state geologist, an advisory member of the oil and gas board. For information on permits, plugging, etc., the reader is directed to contact Dr. E. P. Rothrock, State Geological Survey, Vermillion, South Dakota.

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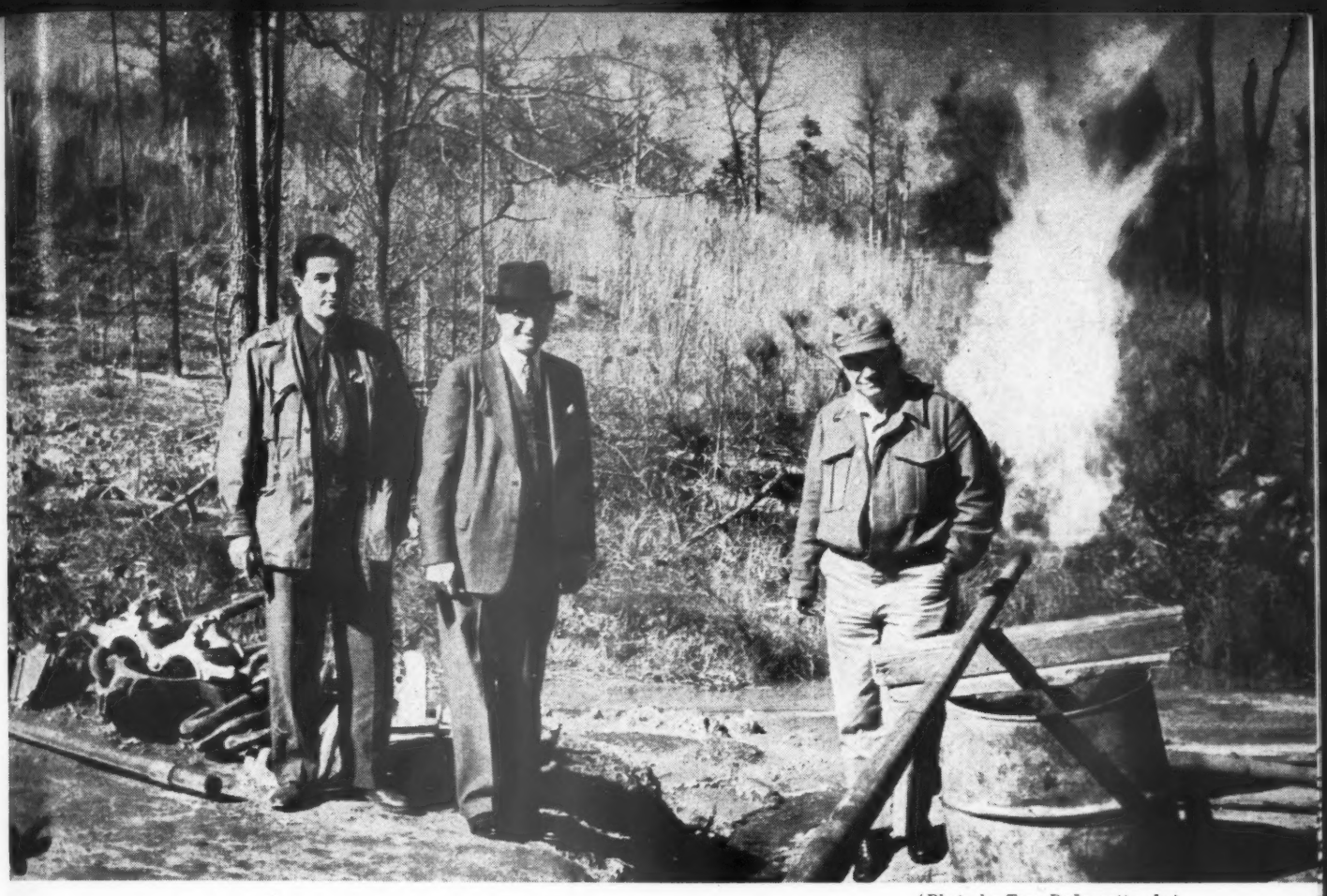

(Photo by Tom DeJarnette, Jr.)

Standing by Cullet's second well in Hamilton field are Fred Mellen, consultant geologist of Jackson, Mississippi, H. L. Cullet, independent operator, and Walter B. Jones, Alabama state geologist, and the author.

P 305.
P 111.

OIL AND GAS IN ALABAMA

Discovery of Pollard field by Humble has increased activity in southern Alabama, where many structures are known to exist

WALTER B. JONES*

IN order better to understand the descriptions of Alabama's oil fields, and chances for new discoveries, a thumbnail sketch of the geology and prospects of the state is necessary. The drilling program has advanced to such an extent that sub-surface geology is gradually unfolding, particularly in the Coastal Plain region. It is still incomplete in many areas, but each new well contributes its answers to unsolved problems. The present situation (see map), according to information available to the writer, is as follows:

*State geologist and oil and gas supervisor, University, Alabama.

Geology

1. Consisting of a full series of beds and containing such well known structures as the Hatchetigbee anticline (Choctaw County) and Jackson fault (Clarke County), this area is regarded to be the most favorable one in the state in which to prospect for oil and gas. Beds outcropping at the surface are Eocene to recent in age. In areas outside of the above named structures, beds of Lower Cretaceous and other Mesozoic formations, not present at surface outcrops, have been encountered in deep tests. It is known that such conditions are conducive to formation of folds, faults, sand lenses, salt domes, etc., in which oil and gas might be trapped. Assignment of top billing to the area is borne out by the existence of all three of the state's oil fields within its limits. Others are expected in the near future, as the drill follows through on indications resulting from surface, geophysical, core drilling, and other studies. Deep tests now in progress in Clarke and Washington counties will provide much valuable information.

2. This is the area of the Warrior Coal fields (Fayette in Fayette County and

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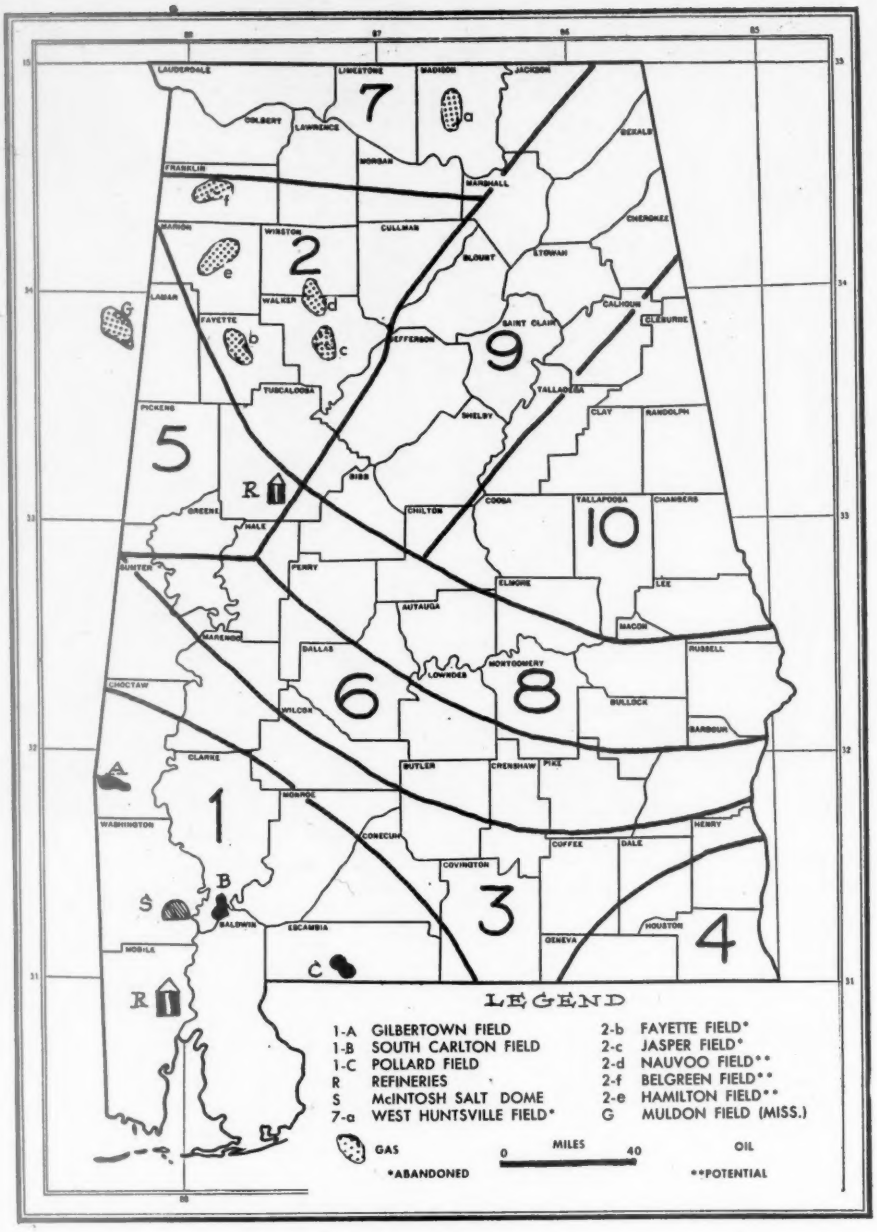

Map of Alabama, showing 10 general geological areas and the oil and gas fields in each, and the refineries. The new gas field in Mississippi is at upper left. The new oil discovery in Alabama is lower center.

Jasper in Walker County) have been abandoned; and three gas fields (Nauvoo in adjacent parts of Walker and Winston counties, Hamilton in Marion County, and Belgreen in Franklin County) are in various stages of development at the present time. The area contains some very good structures, mostly domes and anticlines, part of which should produce oil or gas or both. All of the perhaps 100 wells drilled in the area have had shows of oil and gas. Thus it is just a matter of time. Underlying beds are shale, sandstone, limestone, and dolomite, all of Paleozoic age. This is now considered second best area to prospect for oil and gas.

3. Outcropping at the surface in this region are Eocene and Miocene beds, in which some folding and faulting (e.g. Lower Peachtree anticline and Bethel fault in Wilcox County) are known. Some Lower Mesozoic beds are suspected but the pattern is yet to be determined, because of an insufficient number of wells. It is entirely possible that more of this area may be included in zones 1 and 4 when its sub-surface features are better known. A deep test now in progress near McKenzie, Butler County, will add much to interpretation of sub-surface formations. The four wells drilled in the area have been devoid of shows. Chances for production in the area are very good.

4. This is another area about which little is known. The Columbia-Gordon anticline extends along the right bank of the Chattahoochee River in Houston County. Eocene beds occur at the surface. Too few wells have been drilled to permit an evaluation of sub-surface conditions. Activity in the area is limited to spasmodic leasing. Still it appears to offer good opportunity for production.

5. This is presently one of the "hot-spots" in Alabama because of the new gas-distillate discovery near Prairie, in Monroe County, Mississippi (see G on map). Upper Cretaceous beds outcrop at the surface, obscuring the geology of the underlying Paleozoic strata, from which production may be expected. That condition increases the cost of exploration. Core drilling should not be too expensive, however. Its opportunities rank along with Zone 2, particularly in Lamar and Pickens counties.

6. This is a highly problematical region about which little is known. Many artesian wells exist in the area, completed in the Upper Cretaceous sands, which produce some of the oil in Zone 1. It is now thought that the Upper Cretaceous beds are too thin to contain oil or gas. Nothing is known about the deeper and older beds along the old shore line of Paleozoic and Crystalline rocks, which do appear farther south and may be present here. Sand-lens pools offer the most likely opportunities in this region.

7. Gentle dipping beds of Mississippian (Paleozoic) age outcrop in this area. Some domes and anticlines are known but conclusive tests are non-existent. Shallow gas wells at West Huntsville; shows of gas in a well at Hazel Green; a fine show of oil in a very shallow well near New Hope, all in Madison County; show of oil in the old Goyer well in Lawrence County, and shows of oil and gas elsewhere in the region point to distinct chances for success in well planned and adequately financed projects. Production would come from the Mississippian and underlying Paleozoic beds, with the Ordovician offering the best cover and brighter prospects.

8. This is an area of scant possibilities, where Upper Cretaceous beds form a thin cover over underlying Crystallines and highly folded and faulted Paleozoics, all of which are unlikely to be productive.

9. An area of strongly folded, faulted, and broken beds, it is thought that chances for commercial production are slim. A few wells have been drilled in the area, one of which had shows of gas (Aldrich Dome, in Jefferson County).

10. It has always been considered that the schist, slate, gneiss, granite, marble, etc., in this area of igneous and metamorphic rocks would not be productive.

Oil Field Development

The search for oil in Alabama began in 1865 when Nos. 1 and 2 Watson wells were drilled in Lawrence County. From that date to February 16, 1944, 350 wells were drilled, without success except for the quasi-commercial gas wells at West Huntsville, Jasper, and Fayette, already mentioned. On February 17, 1944, the 351st well, the No. 1 A. R. Jackson, was completed as the state's first commercial oil well. Since then 78 oil producers have been completed.

A. Gilbertown Field. Hunt Oil Com-

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pany's No. 1 Jackson, mentioned above, was the discovery well for Alabama's first commercial field. It was finished off in fracture zones in the Selma Chalk, of Upper Cretaceous age, at a depth of 2800 ft. Since then a total of 68 producers have been completed in the field. Production comes from a fault zone of general east-west trend, along the northern flank of the Hatchetigbee anticline. Usually parallel faults occur, forming a graben, with the oil occurring along the south side of the faulted zone. The oil originated in the Eutaw sands, immediately below the Selma, and a great majority of the wells are completed in the Eutaw. One well produces from both the Eutaw and Selma. The field extends from the Mississippi line almost to the Tombigbee River. The western part of the area is under lease to Hunt Oil Company, and two independent operators. Carter Oil Company has most of the eastern part, with Magnolia Oil Company, and several independents having one or more wells each.

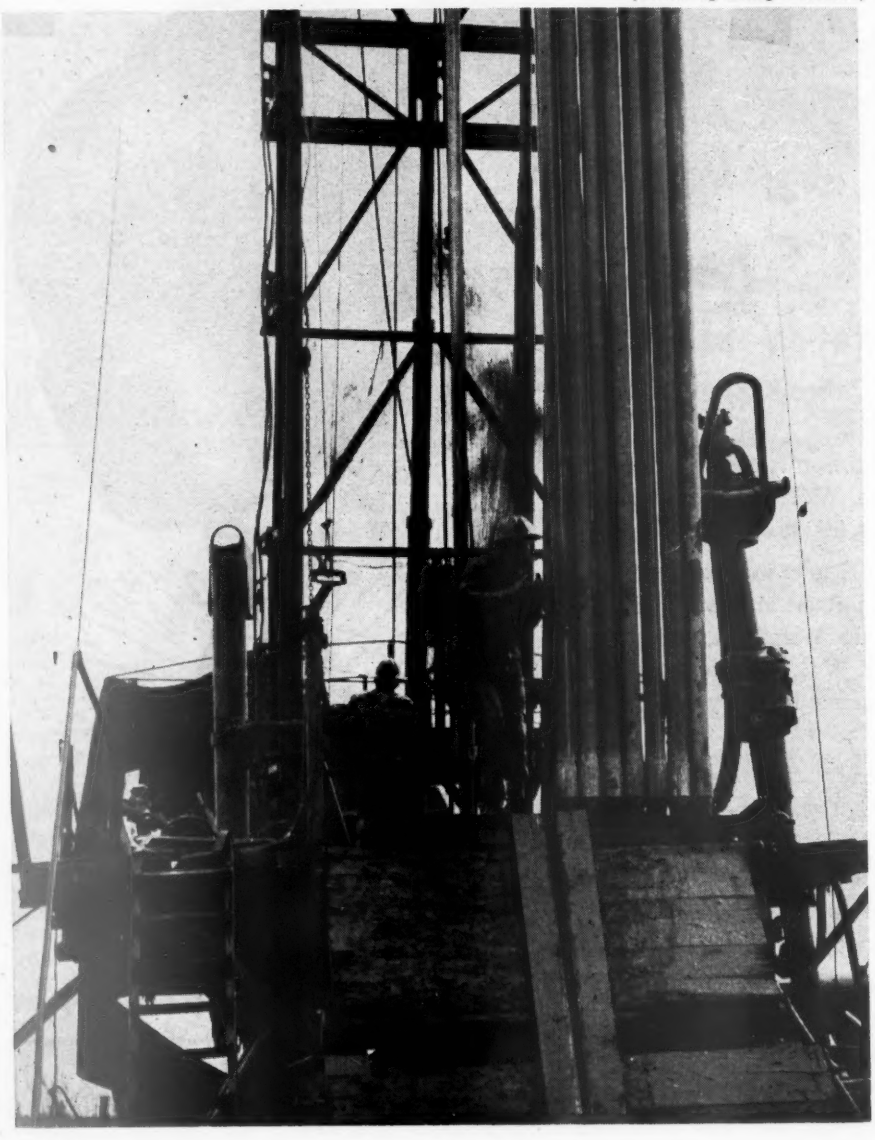
Maximum allowable for the field is 100 bbl: Only 8 wells produce the maximum, all of them in the Carter area. The field has salt water drive, and little, if any, gas. All wells produce varying amounts of salt water. The oil is asphalt base and 19 gravity (API corrected) and brings $1.81 per barrel. Gilbertown production is sent by pipe line to a terminal on the Tombigbee River, thence by barge to Placid Oil Company's (subsidiary of Hunt Oil Company) at Tuscaloosa.

Of particular interest is the plan of Carter Oil Company to drill a deep test (12,500 ft) just north of its best wells, to test deeper formations. Eutaw production comes from depths of 3200-3400 ft. The deep hole will certainly produce some most interesting geology.

Whether or not production will extend to and across the Tombigbee into Clarke County remains to be seen. Several dry holes at the eastern end do not look too favorable. It could be that those are too far north of the fault, however, as it does turn southeastward near the river. A few holes have been drilled on the Clarke County side, without success, although the idea was an excellent one.

FIG. 1. No. 1 Moye still spewing while pipe is being pulled. This is the Humble well that discovered the Pollard field and unleashed a flurry of activity in Alabama.

(Photo by Edley Franklin)



B. South Carlton Field. The discovery well for this field was the No. 1 J. H. Wall Estate, Humble Oil Company, the well being finished off in the Tuscaloosa (Upper Cretaceous) sand at 5917-29 ft. The structure is a stubby anticline or elongated dome. The wells have water drive and the oil is 14 gravity (API corrected). Currently it is bringing $1.35 per barrel. Humble has all leases in Clarke County, while Sun Oil Company has the area east of the Alabama River in Baldwin County. So far, Sun has not drilled any wells, though Humble has continued its work, now having 9 wells, 8 in Clarke and 1 in Baldwin, the latter a unit straddling the river. Humble is drilling a deep test in the center of its cluster of wells, to try for deeper production and higher quality oil.

It would not be at all surprising if the zone between the South Carlton and Gilbertown fields contains other structures that will produce, when the sub-surface conditions are properly evaluated.

It appears that the South Carlton field should have about 35 producers.

C. Pollard Field. Creating Alabama's second "hot-spot", Humble's No. 1 A. W. Moye was brought in on January 19, 1952. Production is from the Tuscaloosa sand, at a depth of 5945-49 ft. Saturated sand was 27 ft thick. In running a drill stem test, the well blew out at the end of 25 minutes (see Fig. 1) and flowed for about a minute. Its potential is estimated at 1000 bbl. Actual production has been 340 bbl through 3/16 in. choke. Oil is 30 gravity and gas-oil ratio is 45 to 1. Shut in pressure is 2600 lb, open 2175 lb. The structure is faulted, with northwest-southeast trend. Since the discovery, two dry holes have been drilled, one 1 mile east and ¼ mile south, and the other one half mile east and ¼ mile south. It is now suspected that the faulted zone contains a graben, and may also be step-faulted. In any event, the discovery is sufficiently important that every possible unit will be drilled.

Geophysical core-drilling uncovered the structure.

Actually the discovery was not too surprising, as Stanolind Oil Company almost made a producer at its No. 1 Steward, finally plugged on September 5, 1951. Oil in the Stanolind well was 25 gravity, also in the Tuscaloosa sand but at a slightly greater depth. The well is 1¼ miles southwest of the No. 1 Moye, perhaps a bit too far down dip.

Acreage in the area is held by Humble, Stanolind, and Gulf Companies. Much title work is being done now. When that is finished the drilling program will be greatly accelerated. The structure appears to be about 5 to 6 miles long. It should support at least 35 wells.

It is interesting to note that other similar geophysical pictures exist in Escambia, Monroe, and Clarke counties. Both geophysical and core-drill work is

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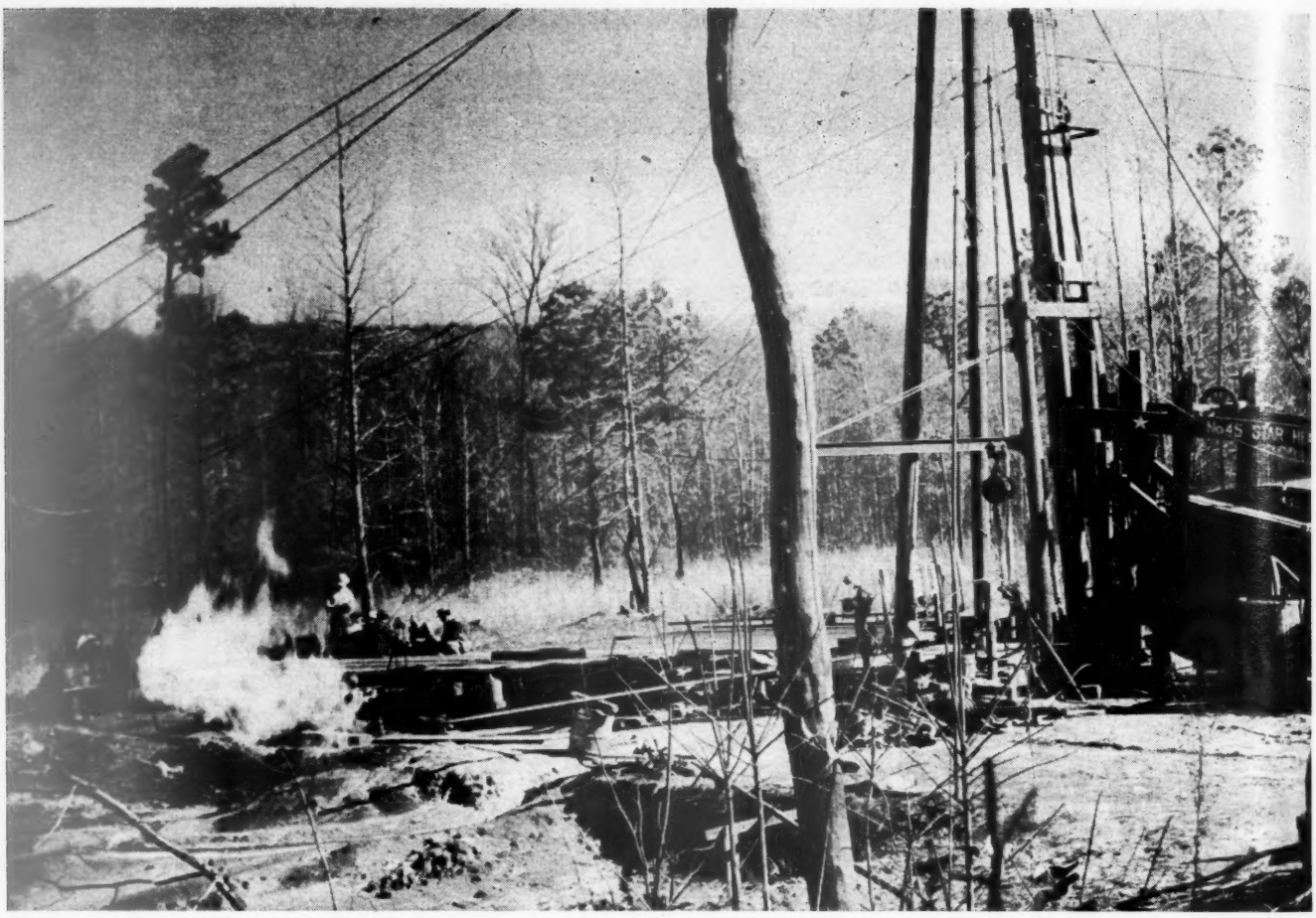

FIG. 2. H. L. Cullet's second well, Hamilton field, in Marion County. *(Photo by Tom DeJarnette, Sr.)*

being pushed, as is leasing. A lot of wells will be drilled in the area, and soon.

Gas Field Development

a. West Huntsville Gas Field. In 1902 to 1908 a series of 10 small gas wells were developed in the Silurian limestone in West Huntsville, Madison County, at depths of 278 to 300 ft. Gas from one of the old wells is still being used by a resident of the community.

b. Fayette Gas Field. In drilling for coal near Fayette in 1909, a slight show of oil was encountered at 475 ft. This led to an intensive drilling program (at least 37 wells) until the project was abandoned in 1917. Some nine gassers were completed in the Fayette sand of the Lower Pottsville of Pennsylvanian age, at a depth of about 1400 ft. The largest well had an estimated capacity of 4,500,000 cu ft with shut-in pressure of 650 lb.

Little use was ever made of the gas. In 1927, the writer visited one of the old wells and drew from it a couple of gallons of heavy, black oil. Deep tests in the area might be successful.

c. Jasper Gas Field. In 1911-12, a group of wells (Shannon) were drilled near Jasper, in Walker County. Three of them encountered gas in the Hartselle sandstone of Mississippian age, at a depth of about 1800 ft. When shot, the wells had an estimated capacity of 150,000 cu ft.

d. Nauvoo Gas Field (Prospect). Since World War II Glenn Rose carried out a partial development of a gas field between Manchester and Poplar Springs in adjacent parts of Walker and Winston counties. Nos. 1 and 2 wells are on the northwest end and flank of the anticline and No. 3 is at the southeast end, and also on the flank. The first well was completed as a small gasser (750,000 cu ft), while the other two were never finished, though each had excellent shows of gas. The area has excellent prospects for a commercial gas field.

e. Hamilton Gas Field (Prospect). Four years ago H. L. Cullet began his No. 1 Lewis, near Hamilton, in Marion County. Losing his first hole, he skidded over and started a new one. This he finished as a small gasser (400,000 cu ft) in the Bethel sandstone, of Mississippian age, at a depth of about 1850 ft. Recently he finished off his second well in the same formation and about the same size (see Fig. 2). This area also has fine prospects.

f. Belgreen Gas Field (Prospect). In a shallow hole (370 ft) northwest of Belgreen in Franklin County, Owen Heath struck a heavy flow of gas that blew his tools out of the hole. Heath has now installed and cemented casing in the hole and is planning his next move. Apparently on a line with the Muldon field, this prospect takes on special significance.

g. Muldon Gas Field. In 1941 Carter Oil Company drilled a wildcat in Monroe County, Mississippi, across from Lamar County, Alabama. Although the well had shows of gas, it was finally abandoned. In November 1951, the plug at 200 ft was drilled out and the well blew out. After five days the well was capped. Then Union Producing Company took over the well, cleaned it out, adequately cased and tested at 7,500,000 cu ft, through 7/16 in. choke. Gas-condensate ratio is 100,000 to 1, with gravity of condensate 66.2. This very important discovery of commercial production in the Paleozoics (production horizon is probably the Hartselle at 5470-5505 ft) opens up a lot of territory in both states that operators have generally shied away from. Leasing has been frenzied.

Conclusions

More than one half of the area of Alabama is made up of formations that might be expected to produce oil or gas. Many structures are known to exist, and many others will be found as sub-surface data build up. Aided by fair but adequate conservation laws, the oil and gas industry in Alabama is about to grow up. It is the writer's studied opinion that Alabama will become a major oil producing state. ★ ★ ★

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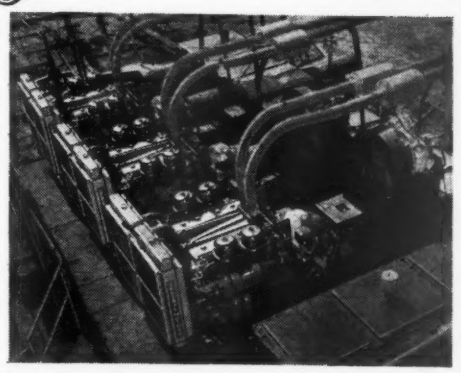

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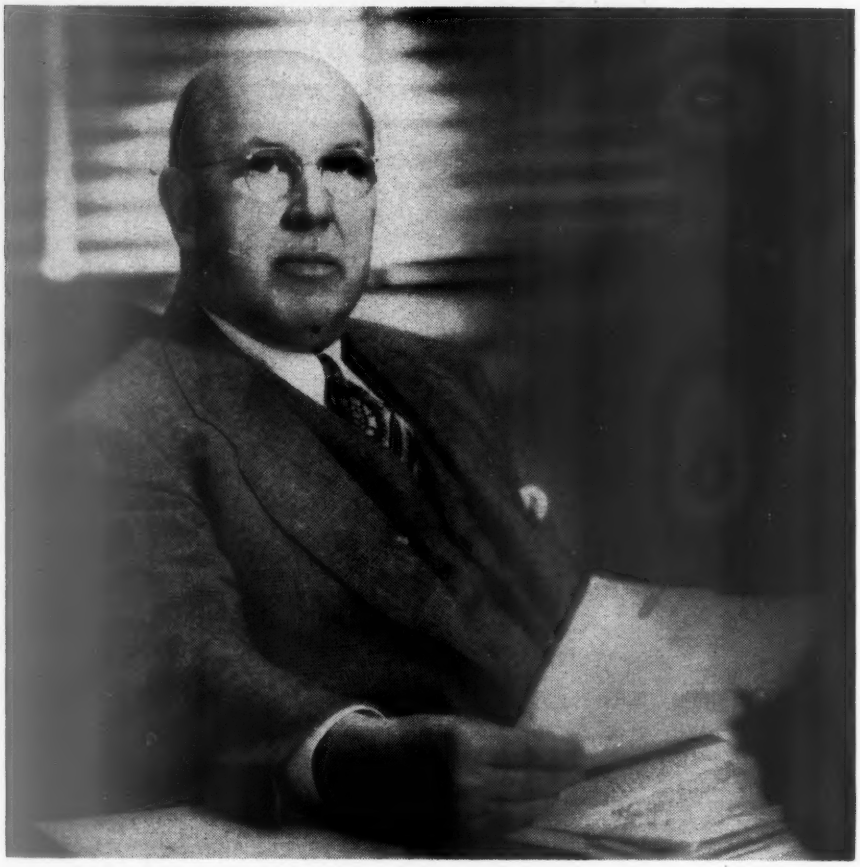


W. G. SKELLY
President
Skelly Oil Company

THE night of March 4 was "Skelly Night" in Tulsa, Oklahoma. William Grove Skelly, known usually as Bill Skelly, has had almost countless honors. In return for the brain power and energy and financial aid he has given to those organizations that he believes further the advance of the human race, he has been given admiration and respect by individuals and by groups.

But that March night the honors came heaped up. The National Conference of Christians and Jews cited Bill Skelly, "honored and beloved Oklahoman and great American", as an exemplar of the principles to which it is dedicated.

Besides the national honor, J. L. Shakely presented him with a silver tray and called him "Mr. Tulsa", because of his constant aid in local civic progress, and Governor Johnston Murray said the new Tulsa-Oklahoma City highway should be named "Skelly Highway" because of the force Bill Skelly has had in advancing state improvements.

It is worthy of note that the Democratic governor of Oklahoma was high in his praise of a man who was Republican national committeeman for the State of Oklahoma from 1924 to 1940. It adds to voluminous testimony that big, hearty Bill Skelly may support an organization confined in scope as a vehicle for accomplishment but he is never limited in friendliness and generosity and understanding so far as his fellow man is concerned regardless of differences of opinion.

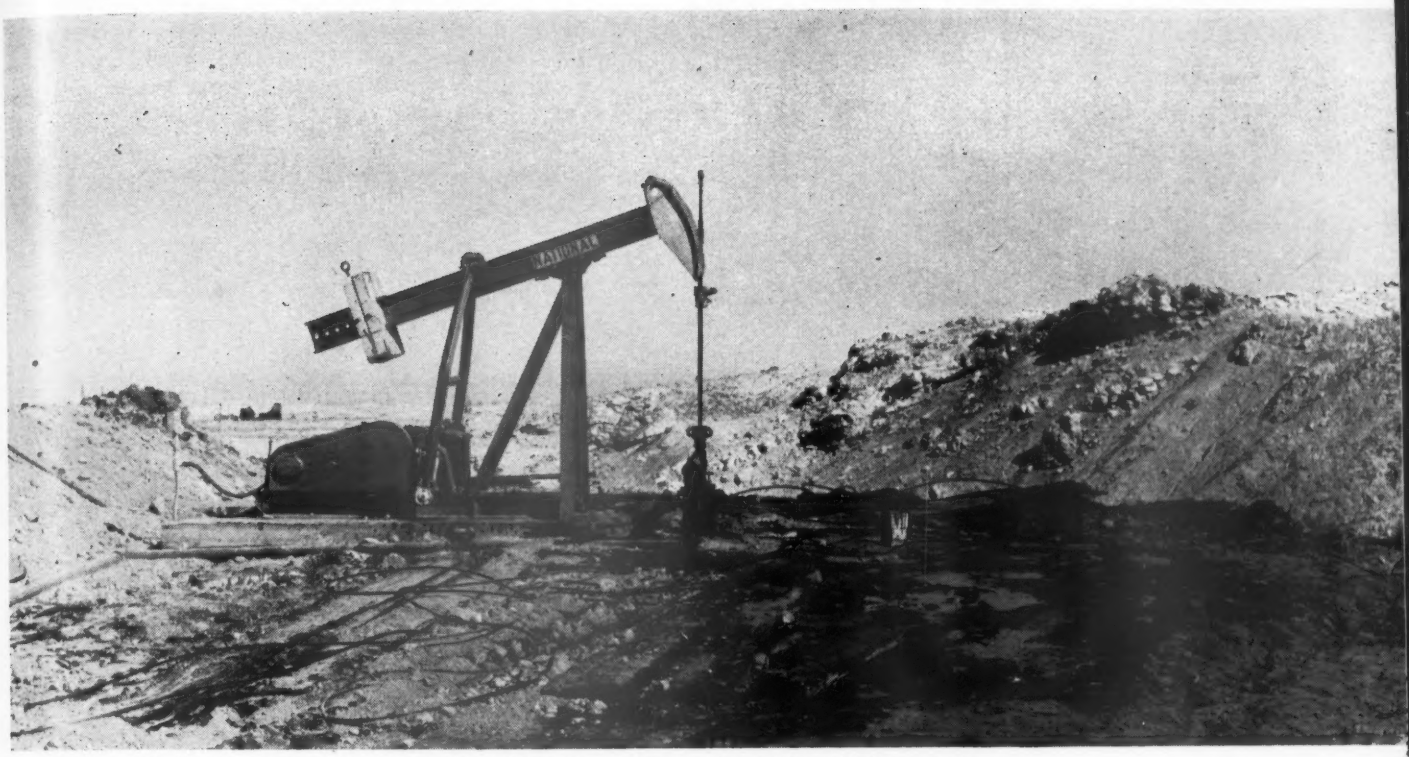
Born near Erie and going to school there, Skelly began work in the oil industry at the early age of 15 years in Venango County, Pennsylvania. In the years since he has made a place for himself in business and in civic affairs such as few have been able to do.

He took time out to serve in the U. S. Army during the Spanish American War and took part in the invasion of Puerto Rico. In 1903 he went into the drilling contracting business in Indiana and extended his activities to Illinois and the Mid-Continent. He acquired leases and producing properties over a large area and with these assets organized in 1919 the Skelly Oil Company. Today the Skelly Oil Company has wide holdings and heavy production of oil and gas. It owns refineries, pipe lines, terminals, and filling stations. It is operated from headquarters in Tulsa and President Skelly is its guiding force.

Outside of the great responsibility of his own organization, he serves as director for many other companies, giving them the benefit of his wide experience. Among these are such corporations as Atlas Life Insurance Company, First National Bank and Trust Company of Tulsa, Oklahoma Natural Gas Company, Great Lakes Pipe Line Company, and Utah Southern Oil Company. He also owns and directs the Southwestern Sales Corporation of Tulsa, which has the KVOO radio station.

In the petroleum industry he is one of the dynamic leaders who works with others through various organizations to achieve the cooperation that is vital to the advancement of the petroleum industry. He is president of the International Petroleum Exposition, works with the American Petroleum Institute, the National Petroleum Council, the Mid-Continent Oil and Gas Association, and many other associations.

Bill Skelly has done and is doing so much, as an oil industry leader and as a patriotic citizen, that it is impossible to describe his activities without book space. How he does it all is hard to understand. Part of the reason is that he earns the devoted loyalty of his assistants in the company and of outsiders with whom he works in various organizations. Perhaps this is one secret of his ability to accomplish the wonders he has.



Surprising well—Abandoned for more than thirty years, Papco No. 1 (above) blew out when the new operator was cleaning it out and sprayed oil all over the location and hill in the background.

Modern Methods Revive McKittrick Lease

A 30-year-old California field comes to life again under administrations of an experienced engineer and geologist

WILLIAM T. RINTOUL

CRUDE oil is being produced again today from a small lease that, thanks to modern production methods, recently ended a shut-in siege of more than 30 years in the McKittrick, California, field.

A new lease on life has been given to the long-idle Papco property by Ralph A. McGoey, Bakersfield, California, a petroleum engineer and geologist of 25 years' experience in the oil fields of California, the Rocky Mountains, and Mid-Continent states.

Several months ago the Bakersfield engineer realized a long-standing ambition to become an operator in his own right when he leased oil and gas rights to 1500 ft for the 20-acre Papco lease, which is one and one-half miles west of the once-booming town of McKittrick in Kern County's famous "West Side" fields.

It took considerable persuasion to

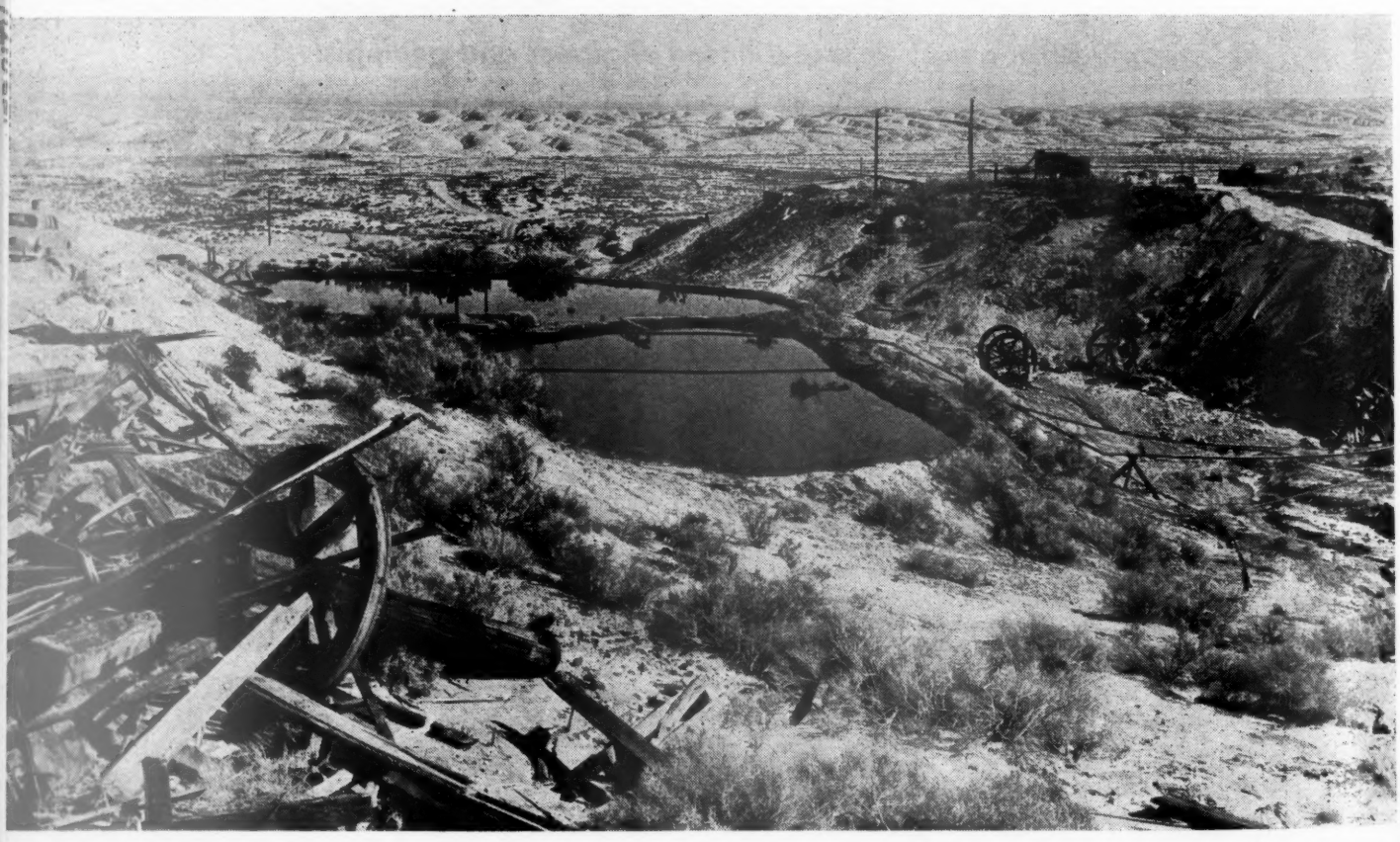
EXCLUSIVE

A legacy of weathered bullwheels, left over from the Papco lease's cable tool days, greeted the new operator when he moved in to begin cleaning-out operations.

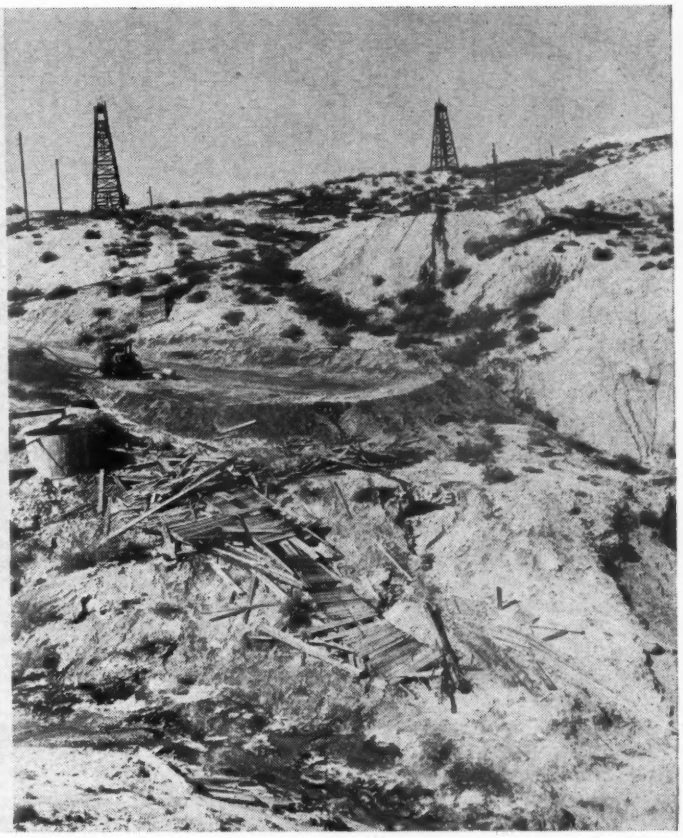
Forgotten sentinel—Blackened casing heads stood out like forgotten sentinels at some of the long-neglected Papco wells.

Oil well?—Finding an oil well can sometimes be a difficult proposition, according to Ralph A. McGoey, shown above probing for the casing in Papco No. 6, which, according to official records, was never abandoned.

Oil storage—Redevelopment of production on the Papco lease brought into use for storage purposes the two earthen sumps shown below. Neither had been used for Papco oil for more than 30 years.



Cleaning-out operations at the Papco wells, which hadn't been produced since 1921, netted a 1912-model heaving chain (above), old pump barrels, three-inch tubing, broken sucker rods, pump seats, plungers, assorted rocks and boulders, bricks, bolts, and other miscellaneous fish.



Collapsed span—Collapse of the wooden span shown in the canyon left Ralph A. McGoey, new operator of the Papco lease, with the choice of resorting to hill climbing or driving one-quarter mile on a round-about dirt road to travel from one end to the other of his hilly 20-acre lease.

coax production from the long-idle Papco wells, which had not been produced since 1921, but today two wells on the lease are netting an estimated 25 bbl per day with prospects that six other wells on the lease will add substantially to that output.

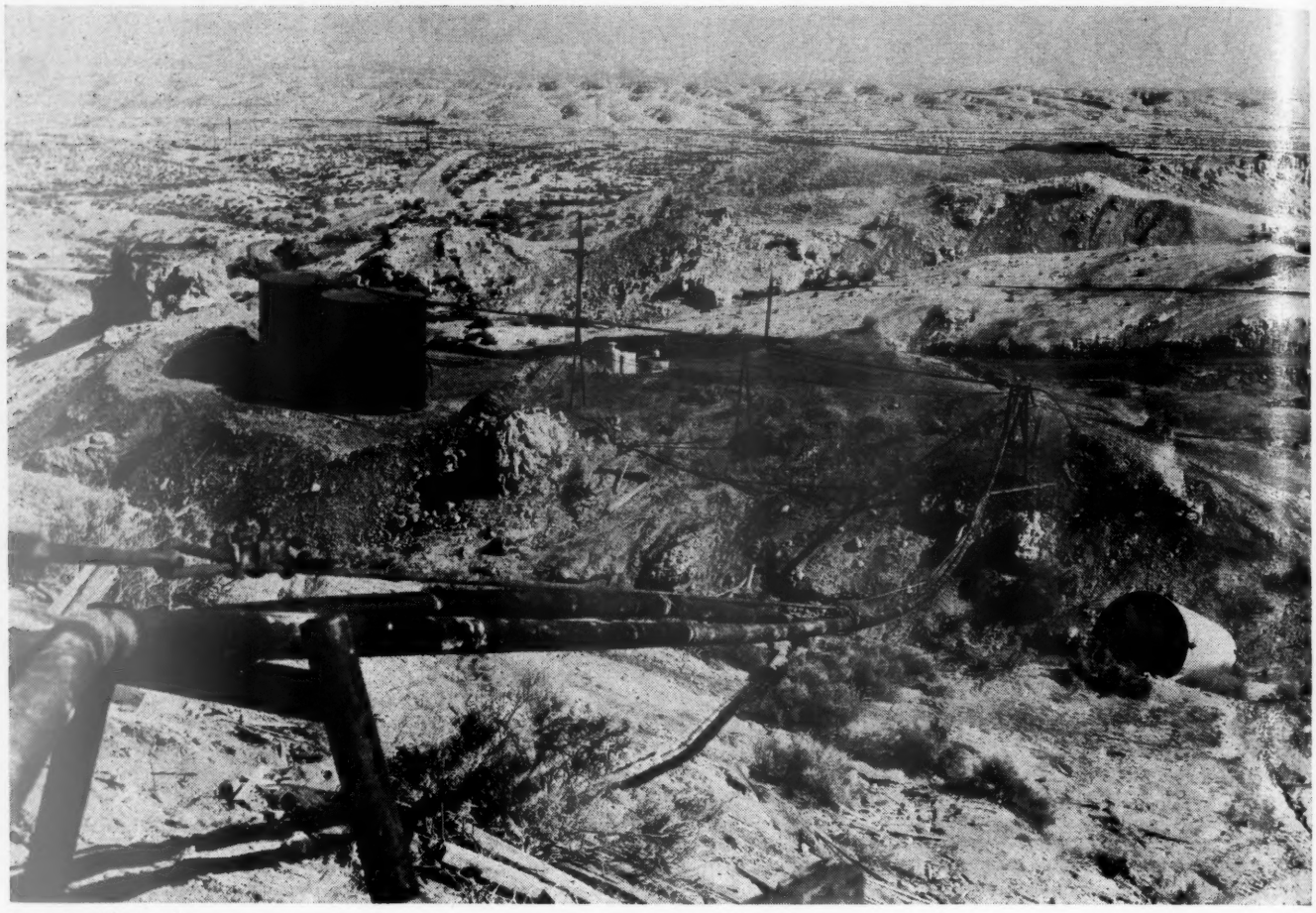
Eight wells had been drilled on the small parcel during the height of the McKittrick boom in 1908-1909, and production reportedly ran as high as 20,000 bbl per month. Wells varied in depth from 900 to 1200 ft. Incomplete lease records showed two of the old wells as having been abandoned.

Plummeting prices shut down the lease in December 1912, and, with the exception of a few days' test production in 1921, the old wells had been idle ever since.

When the new operator moved in to restore production, he found many reminders of the lease's more affluent days. A crumbling concrete foundation marked the site of a compressor plant that had been used during the early days when the Papco wells were produced by means of an air lift.

A wooden suspension bridge, used to link one end of the hilly lease with the other, lay at the bottom of the steep canyon it once had spanned. Structural failure of the span left the new operator with the choice of resorting to strenuous hill climbing or driving about a quarter

New operator—Satisfaction and headaches of operating his own lease now belong to Ralph A. McGoey, below, shown watching oil trickle in from one of his wells. He recently restored to production two wells that had not been produced for more than thirty years.



Suspended pipe—New production at the Papco wells necessitated building of a new tank battery and flow line to handle the output.

of a mile on a round-about dirt road to travel from one end to the other of his 20-acre lease.

Several weathered bullwheels, left over from cable tool days, rusted pipe, and scattered bricks littered the neglected lease.

One of the first jobs confronting the new operator was to find the eight wells that had been drilled on the Papco lease. This did not prove to be as simple as might be expected. Blackened casing heads still marked some of the old wells, but others were almost buried in debris. One of the wells, Papco No. 6, resembled an oil seep more than a bona fide oil well.

Oil bubbling from a hole in the ground was all that was left to mark the old well. A probe of the oil pit to a depth of more than 12 ft failed to reveal the casing, which, at last reports, was still undiscovered underneath the oil-soaked location.

A bull-dozer was brought in to clean off the locations and repair the dusty roads serving the various wells. Then a well-pulling unit was contracted to initiate cleaning-out operations.

An amazing variety of antique junk was recovered by the contract pulling unit, which used virtually every tool of the trade to cope with the many different kinds of fish in the various wells.

Several pieces of blackened junk were fitted together to make a piece of equipment that neither the operator nor well-puller could identify. An equipment company's name was still legible on the broken item and, by referring to the company's 1917 equipment catalogue, the junk was identified as an old-style heaving-plug—a cast iron plug used to keep sand from coming up the hole.

Other junk fished out of the various wells included a 1912-model calf wheel chain, old pump barrels, about 30 ft of 3-in. tubing, broken sucker rods, pump seats, plungers, assorted rocks and boulders, bricks, bolts, and other miscellaneous items.

After fishing an assorted collection of junk from the first well to be cleaned out, Papco No. 4, the operator found bad pipe at about 700 ft and suspended operations pending a redrill job.

Next in line for cleaning-out work was Papco No. 5, which recently was put on production pumping an estimated 15 bbl per day net of 13-gravity oil. Cut has averaged about 50 per cent since the well was returned to production.

After running into bad pipe and more than enough junk in several of the wells, the operator decided to reopen one of the two projects that had been listed as abandoned. Little trouble was encountered in the cleaning-out work, for the abandoned well was relatively free of junk.

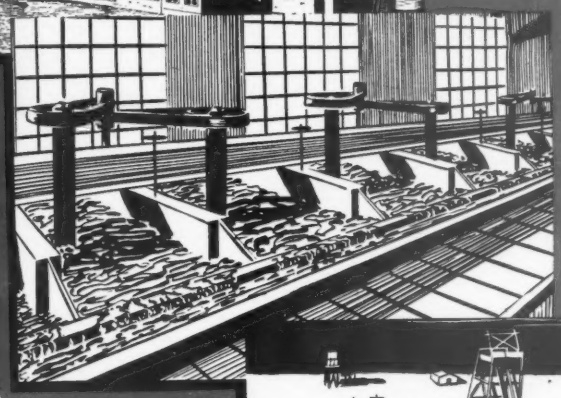
While clean-out work was in progress at the 655-ft level, the well kicked out through the casing with a minor blowout that showered oil for 50-ft radius around the hole. After a 20-minute blow, the surprising well was shut-in. Today the well is netting better than 10 bbl per day of relatively clean 13-gravity oil.

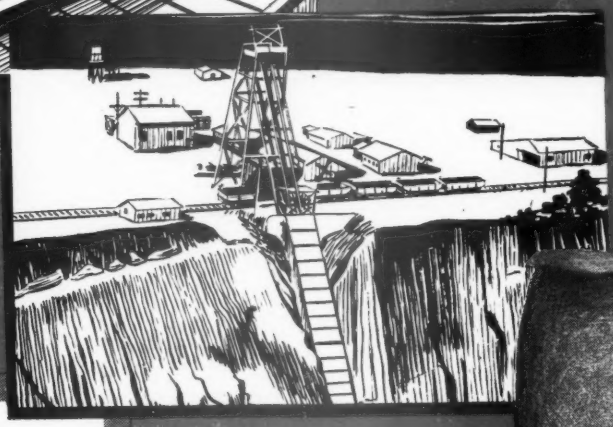
Renewed production from the two wells necessitated installation of two 500-gal storage tanks, a 100-bbl gage tank, and a heater on the lease. A sump hole was used to trap the oil before the tanks were erected.

Present plans call for the redrilling of at least four wells on the Papco lease during the second quarter. In the meantime, both the lease owner and lease operator appear to be well satisfied with the operation.

Lease owner from whom shallow rights were leased is Richfield Oil Corporation. Without other producing wells in the vicinity of the small lease, Richfield, second largest crude producer in California, would find operation of the Papco wells more of a liability than an asset.

As for the new operator, he now has the satisfaction, and the headaches, of having his own lease to operate as he sees fit. Operation of the lease will, of course, be a slow-paying proposition—as all such stripper operations prove to be—but it does look as if the old Papco wells will stand up for a good many years of new production. * * *





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Some Considerations in Selection of Sucker Rods

Problems of elasticity and fatigue and economics in designing rods are reviewed

KENNETH N. MILLS

The Author

Kenneth N. Mills received a BS degree in mechanical engineering from Rice Institute in 1933. After he graduated he joined American Manufacturing Company of Texas and became chief engineer of that company. In 1940 he joined Bethlehem Supply Company as chief engineer. During the war he became works manager for Texasteel Manufacturing Company and later assistant chief mechanical engineer of Emsco Derrick and Equipment Company at Houston. He joined Ideco as machinery products manager at Columbus in 1949. He has been responsible for the development of numerous theoretical approaches to oil well pumping problems.

As the sucker rod string is used to transmit power from the surface to the pump, and this power is transmitted by repeated load applications, its design is a problem in fatigue as well as elasticity and economics. The true nature of the fatigue problem is dynamically illustrated by a comparison of the cycles of loading imposed on the sucker rod string during a year's operation with the number of cycles of stress considered to represent the endurance limit in laboratory fatigue testing. One year of continuous operation at 20 SPM will subject the sucker rod string to a minimum of 10,512,000 cycles of stress. This is slightly in excess of the 10,000,000 cycles of stress commonly assumed to represent the endurance limit in laboratory fatigue testing. Adverse operating conditions, such as pounding fluid, can double the number of cycles of stress per year in addition to increasing the range of stress that lowers the endurance limit. This indicates that the maximum true stress level in the sucker rod string must be less than the endurance limit of the material in the presence of the well fluid, if the sucker rod string is to have infinite life. Economic and practical limitations may prevent the achievement of this idealistic aim in corrosive oil well fluids, because corrosion process is continuous and does not abate after the expiration of a given period of time.

An over-simplification of the problem would indicate that a sucker rod string operating in a non-corrosive well fluid would have infinite life, if the stress level was kept slightly under the laboratory endurance limit for the material. This would be true, if the surface condition of the sucker rod was identical with that of the laboratory test specimen and the ranges of stress were equal. Unfortunately it is economically impractical to make the surface condition of the sucker rod identical with that of the endurance limit test specimen, and therefore the endurance limit of the finished sucker rod is less than the endurance limit of the basic sucker rod material. As the object of the fatigue test is to determine the optimum properties of the metal, the test specimen is carefully machined and polished to remove all points of stress concentration that would lower the endurance limit of the material. When this material is fabricated into a sucker rod, the surface of the rod is not machined and polished. It is used in the as-rolled condition, and therefore the surface will contain surface irregularities resulting from rolled-in-scale that will form points of stress concentration and cause the endurance limit of the sucker rod to be less than that of the material used in the rod. Also the heat used in the rolling operation will reduce the amount of carbon in the surface layer of the rod material, and this carbon loss will cause an additional reduction in the fatigue resistance of the sucker rod material. The exact amount of these reductions will depend on the nature of the material used in the sucker rods. A series of tests made by Hawkins, Becker, and Mills[1] indicates that these surface conditions will reduce the endurance limit of the material 20 to 40 per cent, depending on the chemical composition of the material and its heat treatment.

In addition to the adverse effects resulting from surface condition the sucker rod contains mild points of stress concentration in the upset and threaded sections. The adverse effects of these points of stress concentration depend on operating conditions, and the care used in making up the threaded connections. If operating conditions, such as excessive speed, pounding gas or fluid cause the sucker rod load to change from tension to compression, the rod string will buckle and tend to corkscrew inside of the tubing. As the coupling section of the rod string is larger than the remainder of the string, the tubing will limit its deviation from the axis of the tubing to a value less than that of the rod proper. This restraining action at the coupling will cause high bending stresses (stress concentration) to be induced into the rods near the junction between the upset and the main body of the rod. This effect increases the range of stress imposed on the rod and reduces its effective endurance limit. Also it may induce stresses into the rod in excess of the normally applied load.

EXCLUSIVE

The threaded connection used to join the rods is a natural stress raiser, and will cause pin failure if this connection is not properly tightened. Assuming that the threads and pin faces are clean and undamaged, theoretically this threaded connection will not be subjected to a fatiguing type load, if the pin tension created by the tightening of the joint is slightly in excess of the applied load. Practical experience indicates that this connection must be tightened in accordance with this theoretical value if pin failures are to be kept at a minimum. As overtightening can start a material fracture at the root of the threads that will create a point of stress concentration and cause a pin failure, the tightening torques used to make up the pin joints should be limited to a value that will not stress the pins above the yield point of the material.

The most common stress raisers in sucker rods are created by improper handling. If a rod is accidentally bent and restraightened, tensils and compressive stresses are induced into the rods where it is straightened. The tensils stress thus created will add to the operating tensil stresses and can cause the rod to be overstressed at that point and fail. Nicks and dents resulting from hammering or dropping the rods across a sharp object will form points of stress concentration that may cause the rod to fail in fatigue. The rods may be damaged by a drop resulting from a rod parting, or they may be overstressed in pulling on a stuck pump. Sucker rod overstressing when pulling a stuck pump can be prevented by using a weight indicator or using rod stretch as a measure of the pulling force. The maximum allowable stretch for sucker rods made of materials having various yield points is shown in Fig. 1.

The endurance limit of the common carbon and alloy steels in air is directly related to the tensil strength of the material. This is illustrated by the diagram shown in Fig. 2, which was developed by

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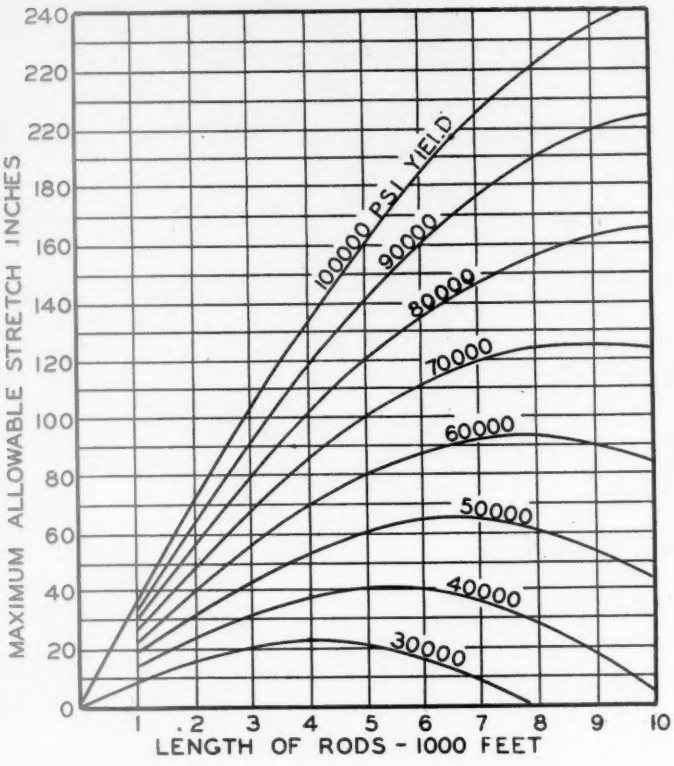
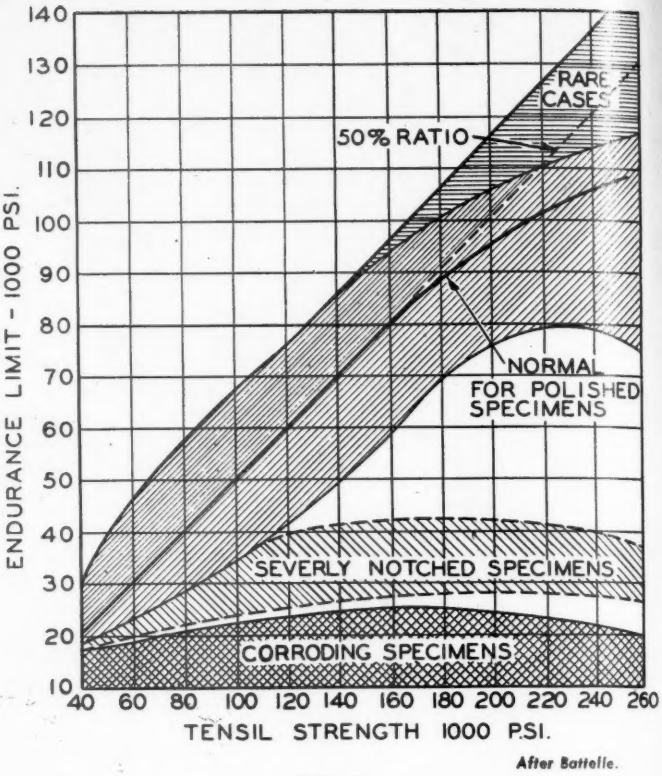


FIG. 1.



After Battelle.

FIG. 2.

Battelle Memorial Institute.[2] In this illustration it will be noted that for steels with a tensil strength less than approximately 160,000 psi, the endurance limit is approximately 50 per cent of the tensil strength. This relationship between tensil strength and endurance limit is independent of the chemical composition of the steel and is primarily dependent on the hardness of the steel. The alloys commonly used in sucker rod steels increase the corrosion resistance of the steel and its toughness. In this illustration it will be noted that severe notches and corrosion materially reduce the endurance limit. Naturally, the amount of this reduction is dependent on the nature of the notches and the action of the corrosive agent.

When sucker rods are operated in water cut or corrosive well fluids, the material is subjected to corrosion fatigue, and its basic endurance limit is materially reduced. The magnitude of this reduction is dependent on the activity of the corrosive agent on the sucker rod material, and it develops in the following manner: First, the corrosive agent attacks the metal and forms a film on the metal that tends to protect the metal from further corrosion. The repeated stress applications cause this film to crack, and the corrosive action on the base metal is concentrated at these cracks. This concentrated action of the corrosive agent forms relatively deep pits,, which act as stress raisers and materially reduce the fatigue strength of the material.

The problem of corrosion fatigue has been studied for a number of years, and while a vast store of information has been accumulated, it does not give all the answers that are desired in the application of sucker rods. Beginning in 1925, D. J. McAdam, Jr.,[3] began an extensive study of corrosion fatigue. He found that even the pressure of pure water may reduce the endurance limit of steel to a value far less than that found in air. As corrosion is a time function, no definite limit for the endurance limit has been found for indefinitely long life under corrosive conditions. In view of this fact, the results of corrosion fatigue tests are of little value in the application of sucker rods and should be viewed as material evaluation tests. Assuming that the corrosion fatigue test is conducted at 1750 cycles per minute, about 4 days will be required to reach 10,000,000 cycles of stress. When this material is used in a sucker rod, 347 days will be required to subject it to 10,000,000 cycles of stress, if the well is pumped at the rate of 20 SPM. Therefore, the action of the corrosive agent on the test specimen will not be comparable with that on the actual sucker rod, and the corrosion endurance limit of the sucker rod will be substantially lower. This has been borne out by corrosion fatigue tests conducted at lower speeds, as the values of corrosion endurance limit found at low speeds have been substantially lower than those found at high speeds on identical materials.

If the corrosive agent liberates nascent hydrogen when it attacks the steel, and this gas is absorbed by the steel, it will become brittle. This phenomena is commonly known as hydrogen enbrittlement and commonly occurs when hydrogen sulfide gas is present. As the hydrogen gas is liberated and absorbed in the corrosion pits, and decreases the toughness of the material at this point, the adverse effect of the notch as created by the corrosion pit is materially increased. This materially lowers the corrosion fatigue strength of the material.

Basically, alloys are used in sucker rod steel to improve their resistance to corrosion. As most sucker rods use the sheet in its normalized state, they also improve the physical properties of the material, and therefore increase the load carrying capacity of the sucker rod. Steel containing manganese up to 1.65 per cent, carbon, silicon and small amount of phosphorus and sulfur are classified as carbon steels. Alloy steels are produced when other metallic elements are added. Carbon is an essential ingredient in steel, and it is a very effective hardening agent. As the carbon content is increased, the susceptibility of the steel to heat-treatment increases, and the corrosion resistance, ductility and impact resistance decreases. Manganese is an essential element in steel, as it acts as a deoxidizer and combines with sulfur to make the steel less brittle. Its effects on corrosion resistance and hardenability are similar to those of carbon, but on a reduced scale. Silicon is used in sucker rod steels as a deoxidizer, and it is a necessary part of the steel making process.

Alloying elements such as nickel, chromium, molybdenum, and copper are used to increase the hardenability of steels. In sucker rod steel they can be used to replace carbon as a hardener and obtain equivalent or greater strengths with increased toughness and corrosion resistance. Nickel is very effective in increasing corrosion resistance, and it

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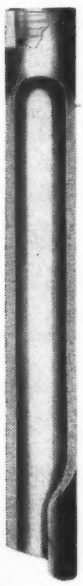

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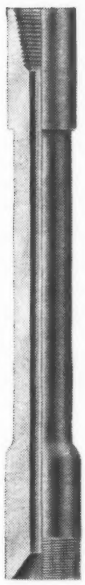

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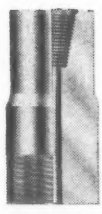

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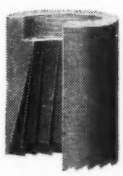

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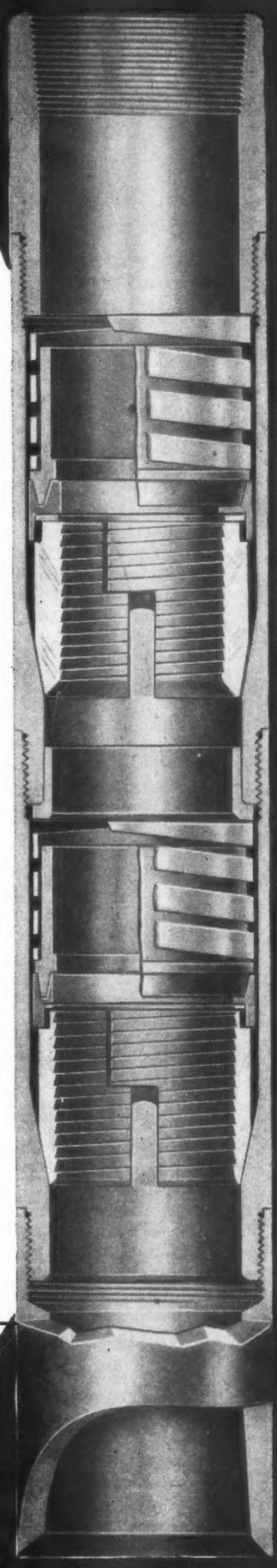

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FIG. 3. After Alman.

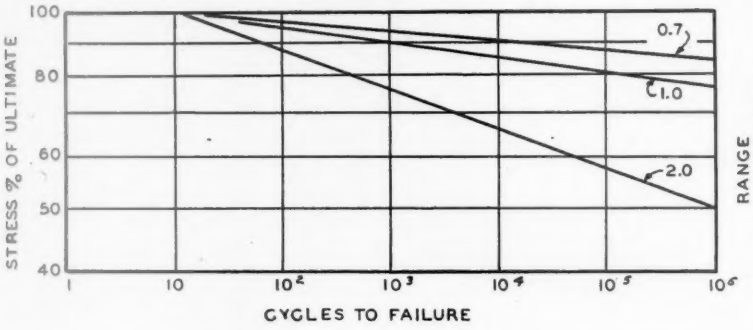
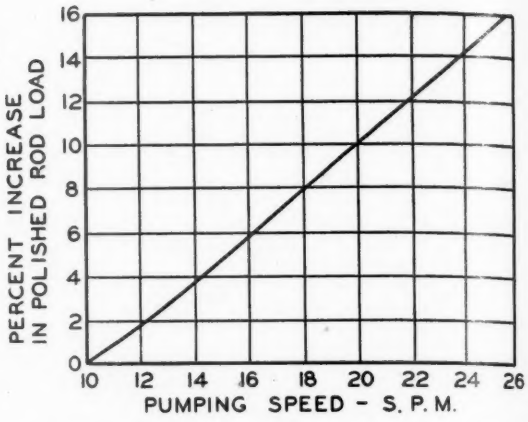


FIG. 4.



improves the resistance of the steel to hydrogen embrittlement. Chromium improves the corrosion resistance of the steel, but it is less effective than nickel. Molybdenum is a very effective hardening element, and therefore it can be considered as a strength improver in sucker rods. It has little, if any, effect on corrosion resistance. Copper is quite effective in improving the resistance of steel to atmospheric corrosion, and therefore it should improve the resistance of steel to oil well corrosive elements. Sucker rods are available containing various amounts and combinations of each of these elements to meet various well conditions.

The fatigue resistance of any material is dependent on the range of stress. Most endurance limit tests are made on rotating beam fatigue testing machines. In this type machine the specimen is subjected to a bending load that imposes tensil and compressive stresses of equal magnitude in the outer fibers of the material. The specimen is mounted so it can be rotated, and this subjects a given spot on the specimen to alternating tension and compression stresses of equal intensity. In this case the stress range is 2. If the load were such that the stress ranged from zero to a mixi-mum the stress range would be 1, and the endurance limit would increase over the value found for a stress range of 2. The effect of stress range on the endurance limit as set out by Alman[4] is shown in Fig. 3. In this illustration it will be noted that the endurance limit increases as the range of stress is decreased.

As operating conditions influence the magnitude and nature of the sucker rod load, they should be chosen to give the most economical balance between sucker rod initial and maintenance costs and the initial cost of surface equipment. The sucker rod load can be calculated with the equation:

$$P.R.L. = {}^{W}F + {}^{W}R\left(1 + \frac{LN^2}{70{,}500}\right)$$

where

PRL = polished rod load, pounds
^{W}F = weight of fluid on net plunger area, pounds
^{W}R = weight of rods in air, pounds
L = Length of surface stroke, inches
N = strokes per minute

From this equation it is apparent that the length of surface stroke and the pumping speed are important factors in determining the magnitude and nature of the sucker rod load. The effect of pumping speed on the polished rod load for a constant pump size, rod size and production rate is shown in Fig. 4. This indicates that slow pumping speeds are desirable if minimum polished rod loads are to be achieved. As sucker rods normally fail in fatigue that involves some number of cycles of loading, the number of barrels of oil lifted per sucker rod break will increase as the speed is decreased, and the stroke length increased to give a constant production rate. As increasing the length of the surface stroke increases the torque loading imposed on the surface machinery the economic gains resulting from the increased sucker rod life must be balanced against the increased initial cost of the surface equipment.

When designing a pumping installation where it is desired to lift the maximum fluid volume, the maximum pumping speed may be limited by longitudinal vibrations (5,6) in the sucker rod string or the ability of the rods to follow the surface motion. The action of the pump induces longitudinal vibrations into the sucker rod string, and it is desirable to select pumping speeds that are not synchronous with the first and second order of these vibrations. If the pumping speed is synchronous with these vibrations it will increase their intensity and materially increase the sucker rod load. In most instances, the vibration energy loss due to friction is of sufficient magnitude to prevent the creation of high sucker rod loads when the system is operated at a speed that is synchronous with the third order vibrations. These speeds should be avoided if convenient, however. Due to friction losses, the higher order synchronous speed can be neglected. The natural frequency of longitudinal vibration of the rod string is represented by the equation:

$$F = \frac{237{,}000}{L}$$

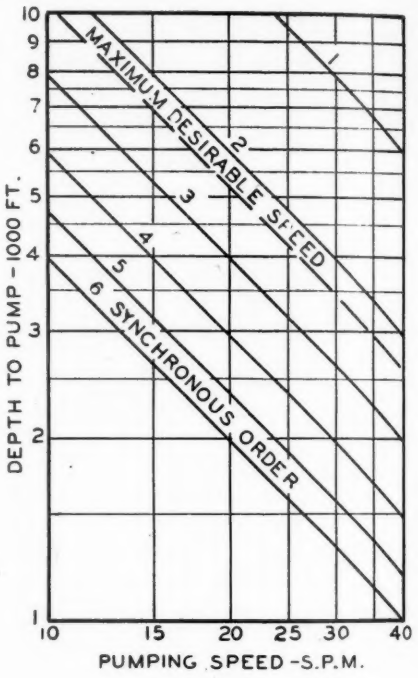


FIG. 5.

F = natural frequency, cycles per min.
L = length of rod string, feet

The synchronous speeds and maximum desirable speeds for various well depths are shown in Fig. 5.

To prevent subjecting the sucker rods to severe impact loads, the maximum pumping speed must be limited to a value that will permit the rods to follow the motion of the walking beam. If the system is operated at a higher speed, the polished rod clamp will leave the carrier bar at the start of the down stroke and fall freely before re-contacting the carrier bar. This will subject the sucker rods to a suddenly applied load and materially increase the maximum load in the rods. Also, it materially increases the range of stress and lowers the endurance limit. The speed at which this condition occurs is difficult to predict because it depends on down-the-hole friction and the motion characteristics of the surface machinery. The following formula will give a good ap-

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proximation of the maximum pumping speed for free rod fall in most instances.

$$\text{Max SPM} = \sqrt{\frac{60{,}000}{L}}$$

where

L = length of stroke, inches

A graphical solution of this equation is shown by the line marked approximate maximum pumping speed in Fig. 6. The maximum desirable speed as shown in this illustration includes a factor of safety to allow for unknown well conditions and should be safe in all applications except possibly installations pumping very low gravity fluids.

As the weight of the rods is one of the principal factors influencing the polished rod load and, therefore, the size of the surface machinery, care should be used in selecting sucker rod sizes to assure minimum surface equipment loads. The total weight and cost of the sucker rod string can be reduced by using a sucker rod string composed of two or more sizes of rods. To obtain the maximum load reduction from a tapered rod string, it should be designed so the unit stress in the upper most rod of each size is equal. To achieve this aim the lengths of each size of sucker rod must be adjusted to match the pump plunger size. The percentage constants for designing double and triple-tapered rod strings are shown in Table 1. Tapered rod string can be used in any depth well. Due to inventory and field maintenance problems, however, their use is generally limited to the deeper wells. As a general rule, rod strings composed of two sizes should be used in wells over 4000 ft in depth, and rod strings composed of three sizes should be used in wells over 6500 ft in depth.

Due to the large number of variables involved in the corrosion problem and our very limited knowledge of the entire sucker rod fatigue problem, it is not possible to develop a rational approach to the maximum permissible stress level in sucker rods. Therefore, the maximum allowable stress level for a given type of rod operating in a given environment must be based on experience. Now, to some, this un-scientific approach may appear to be sacrilege. It is common practice in all fields of machine design, however, as all the working stress in machine elements are based on experience, or extensive fatigue tests on full size models of the machine elements. Allen, Beal and Curtis[7] have made an interesting analysis of the sucker rod working stress problem. They have correlated the rod failure frequency on a number of wells ranging from 5000 to 7000 ft deep during a period of approximately one year with the stress intensity. The results of this correlation are shown in Fig. 7. In this correlation it will be noted that they expressed the working stress intensity in per cent of the yield strength of the rod material. This analysis would indicate that the maximum unit stress should be between 30 and 35 per cent of the yield strength of the sucker rod material. It also indicates that the number of rod failures will increase as the stress level is increased.

Table 1.

Plunger diameter, in.	¾, ⅞ in. % ¾ in.	⅞, ¾ in. % ⅞ in.	⅞, ¾, ⅝ in. % ⅞ in.	⅞, ¾, ⅝ in. % ¾ in.	⅞, ¾, ⅝ in. % ⅝ in.	1, ⅞ in. % 1 in.	1, ⅞, ¾ in. % 1 in.	1, ⅞, ¾ in. % ⅞ in.	1, ⅞, ¾ in. % ¾ in.
¾	27.0	23.8							
15/16	28.9	24.6							
1	29.6	25.0	19.3	23.0	57.7	22.7	16.7	19.0	66.3
1 1/16	30.5	25.5	20.3	23.4	56.3	23.1	17.2	19.5	65.3
1 1/4	33.2	27.3	22.6	26.1	51.3	24.3	18.7	21.2	60.1
1 1/2	37.4	29.6	26.5	30.2	43.3	26.2	21.1	23.9	55.0
1 3/4	42.3	32.9	30.6	35.2	34.2	28:4	23.9	27.0	49.1
2	48.2	36.5	35.7	41.0	23.3	30.9	27.1	30.7	43.2
2 1/4	54.4	40.6	42.0	47.0	11.0	33.8	30.9	34.8	34 3
2 5/16	59.8	44.0				36.2			
2 1/2	63.0	45.0				37.0	35.0	39.5	25.5
2 3/4	69.7	50.2				40.6	39.5	44.6	15.9
3 3/4		75.4				58.2	44.5	50.2	5.3
4						58.5			

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FIG. 6.

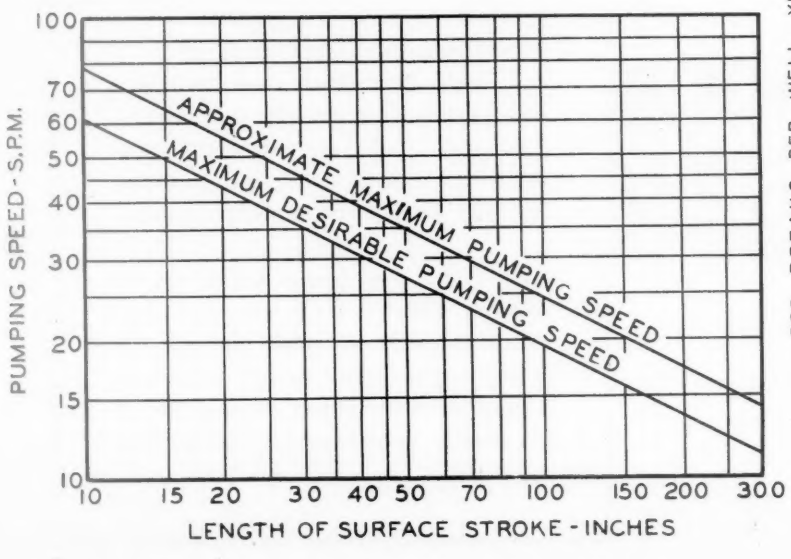
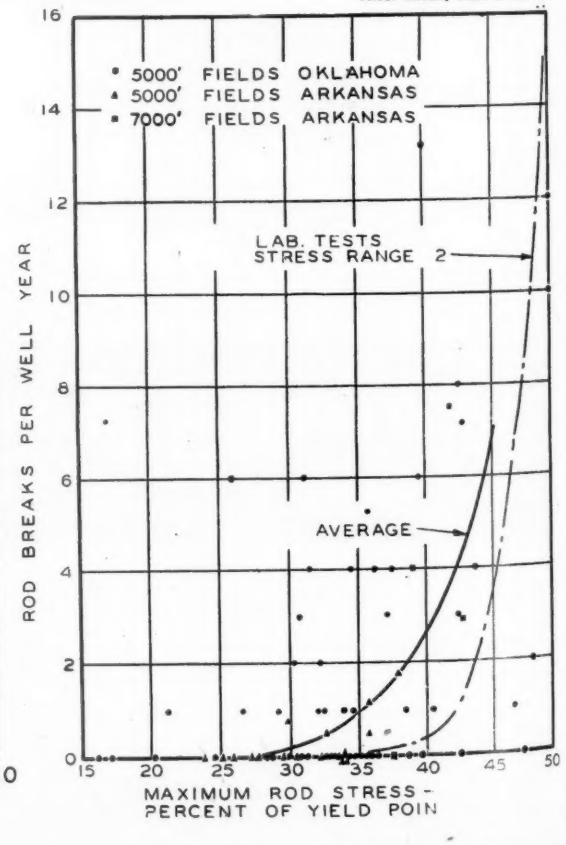


FIG. 7.

After Allen, Beal & Curtis.



Natural Organic Colloids of Iranian Origin As Mud Treating Agents

Gums play important part in reducing water loss, as plugging agents, and as protective colloids

GEORGE TCHILLINGARIAN AND CARROL M. BEESON

Abstract

A study was made of the effectiveness of Iranian gums and gum bearing seeds in reducing water loss in five different types of salt-water and fresh-water muds. Tests were performed at 68 F and at 180 F, and included determinations of water loss, viscosity, gel properties, and foaminess.

It was found that the addition of these colloids improved markedly the filtration characteristics of all of the muds tested, including high pH red lime-base mud. Increasing the temperature from 68 F to 180 F increased the effectiveness of gum shiras and, to a lesser extent, of locust bean seed, showing them to be very valuable treating agents.

The results of the investigation indicated that Iranian gums, quince seed, or locust bean seed would prove extremely useful in drilling in the salt-dome area of the Near East and in other parts of the world.

THE industry is becoming more conscious of the importance of good muds in the drilling of oil wells. Poor plastering properties cause excessive filtration, which promotes heaving of bentonitic or other swelling formations. A thick mud sheath leads to stuck drill pipe and difficulty in running casing. Furthermore, the penetration of filtrate or solid particles into the oil bearing stratum may have a marked influence upon the rate of subsequent production of oil from the sand.

Electrolytes are outstanding among the many factors that have adverse effects on filtration. The effect is one of flocculation of the colloids by neutralization of the negative charges on the clay particles. This reaction is further increased because of high temperatures that reduce dispersion to a minimum, causing increased flocculation in both fresh-water and salt-water muds.

The reduction of fluid loss by the addition of organic colloids has been studied by various investigators.[1,2,3,4,5] The present research was conducted for the purpose of investigating the usefulness of natural gums and similar colloids of Iranian origin in reducing the water loss of both salt-water and fresh-water muds. The control of salt-water muds will present acute drilling problems in the salt-dome areas of the Near East. In addition, it was believed that the results of the study might promote the use of Iranian gums or gum bearing seeds for treating drilling muds in the United States and in other parts of the world.

Theory of Control of Water Loss with Gums

Apparently gums play a double role in reducing the water loss, acting both as plugging agents and as protective colloids. The molecular size of gums seems to be an important factor in reducing the water loss of drilling fluids. The permeability of the average filter cake, resulting from the packing of clay particles, is of the order of one-thousandth of a millidarcy. Hence, if the gum molecules are large enough, they can plug off the pores and thereby reduce the water loss.

The behavior of gum arabic supports this theory. Being of small molecular size, it acts unfavorably in comparison with other gums on reducing the water loss. The partial reduction of water loss in this case is attributive to its action as a protective colloid. It is known that the stabilizing action of protective colloids is due to the attachment of the protective colloid to the particles, and thus there arises a hydrophilic dispersion where each particle has an insoluble nucleus.

The protective action of gums was demonstrated by the following test: The addition of silver nitrate to saturated salt water results in the formation of a voluminous white precipitate of silver chloride. On adding a small amount of gum the precipitate is completely peptized, and hydrophilic dispersion results. This hydrophilic dispersion acts as an ideal mud with a water loss in the order of 3 or 4 ccs. Hence, an interesting possibility arises, namely drilling fluids formed by peptizing different precipitates.

Experimental Methods

The muds were prepared in the laboratory and aged at room temperature for a period of one week. The gums and whole seeds were ground in a hammer mill to particles smaller than 80 mesh. After addition of the ground treating agents, samples were stirred at high speed with a Hamilton Beach mixer for half an hour. The treated samples were allowed to stand for 45 hours and were stirred in the same manner for another half hour, before being tested.

In determining foaminess, samples treated and mixed as above were allowed to stand for one-half hour, and the foaminess was recorded as the percentage increase in volume over that of the unstirred sample. Octyl alcohol (2-ethyl hexanol) was used, at a concentration of 0.1 per cent, as an antifoaming agent in all samples tested for any property other than foaminess.

All other tests were made according to API Code No. 29, "Recommended Practice for Standard Field Procedure for Testing Drilling Fluids", third edition (1950).

The aqueous base for each salt-water or brine mud was prepared by adding sodium chloride to fresh water.

[1]References given at end of the paper.

EXCLUSIVE

The Authors

G. Tchillingarian C. M. Beeson

George Tchillingarian, who was born in 1930, is a native of Teheran, Iran. His undergraduate and graduate work were mostly done at the University of Southern California, where he obtained a degree of BE in 1949 and MS in petroleum engineering in 1950. He is a member of Tau Beta Pi. At the present time he is teaching assistant in petroleum engineering and is working for a PhD degree in geology. He has also been active in promoting friendship between Iran and the United States.

Carrol M. Beeson earned a BA degree from UCLA in 1935 and a PhD degree from Cal Tech in 1938. For the following nine years he worked for General Petroleum Corporation, most of the time as supervisor of the production research division. Since February 1948, he has been associate professor of petroleum engineering at USC. He is an active member of AIME, ACS, and API.

Experimental Results

Effect of Organic Colloids at 68 F

Tragacanth Gum. One of the substances that brought about a marked improvement in the wall building properties of different drilling fluids was tragacanth gum. Only cheaper varieties were chosen for tests. The cheaper and darker varieties are more desirable for drilling fluids because of their lesser tendency to foam, while their effectiveness in reducing water loss does not appear to vary with grade.

The results shown in Fig. 1 are typical. Fig. 1 shows the effect of tragacanth gum on the viscosity, filtration, and gel strength of a 20 per cent P-95 fresh-water mud. The water loss decreases rapidly with small additions of gum from an original 32.8 cc in 30 minutes to 10.5 cc after the addition of 0.6 per cent of tragacanth gum. Mud containing 1.0 per cent of gum has a water loss of only 7.8 cc. The viscosity of the mud increases continuously from 2.5 to 26.4 centipoises on addition of 1 per cent tragacanth.

Straight Water-Gum Mud. A saturated salt-water mud, with 1 per cent tragacanth (No. 31) and only 3 per cent Wilmington Slough clay, has been prepared that had the following properties:

Viscosity, centipoises	20
Initial gel strength, gms.	2
Ten minute gel strength, gms.	4
Water loss, cc. in 30 min	4.1
Cake thickness, 1/64 of inch	0.2
Foaminess, cc/100 cc mud	35
pH	9

Due to the fact that 3 per cent Wilmington slough is equivalent to some shales incorporated into the mud in the process of drilling, this presents a possibility of using straight water-gum mud. It can be seen that this mud with low water loss and reasonable viscosity can be used in the future in parts of Iran where the clay is not readily available. Remembering the fact that 1 per cent gum tragacanth is equivalent to 3.5 lb per barrel, this mud is also quite economical.

Gum Ghatti. Ghatti gum was found superior in improving the filtration properties of various drilling fluids.

The effect of ghatti gum on filtration, viscosity and gel strength of fresh-water mud is shown in Fig. 2. The 30-minute water loss is decreased from 32.8 to 9 cc. by the use of 0.6 per cent ghatti gum. Increasing the concentration to 0.9 per cent brings about a further decrease to 6.4 cc. Viscosity rises from the original value of 2.5 to 7.8 centipoises on addition of 0.9 per cent gum. Gel strengths do not increase continuously but tend to level off between concentrations of 0.6 and 0.9 per cent.

The addition of ghatti to flocculated salt-water muds considerably reduces the gel strengths (initial and 10 minute) of original mud. For instance, in 10 per cent brine mud (10 per cent Baroco clay) the addition of 1 per cent gum ghatti reduces the initial gel strength from 17 grams to 0, and the 10-minute gel strength from the original value of 22 to 2 grams. This is probably due to the dispersing action of gum ghatti, which acts as a protective colloid. At the same time the addition of 1 per cent gum ghatti to 10 per cent brine mud reduces the water loss from the original value of 52 cc. in 30 minutes to 5.5 cc., although there is only slight increase in viscosity (from the original value of 4.7 centipoises to 5.9). Muds treated with gum ghatti show greater tendency to foam on increasing salt concentration; however, they can be easily treated.

There is a possibility of using gum ghatti instead of starch in high pH mud. The viscosity and filtration effect of ghatti is analogous to starch. A smaller quantity is required to produce the same result, however. The addition of 2.1 per cent gum ghatti reduces the water loss to 2.4 cc. in 30 minutes from the original value of 19 cc., while increasing the viscosity to only 12 centipoises from the original of 3 centipoises. (See Table 4).

Gum Shiras. Fig. 3 shows the effect of gum shiras on the viscosity, filtration, and gel strengths of fresh-water mud (20 per cent P-95 clay). The water loss decreases rapidly with small additions of gum from an original 32.8 cc. in 30 minutes to 11.5 cc. after the addition of 0.6 per cent gum shiras. Mud containing 1.0 per cent of shiras has a water loss of 9.1 cc. Viscosity of the mud rises continuously from 2.5 to 8.4 centipoises on addition of 1.0 per cent gum. Gum shiras was also found effective in reducing the water loss of various salt-water muds. The addition of 1.6 per cent gum shiras decreased the water loss of 10 per cent brine mud (10 per cent Baroco clay) from the original value of 52 cc. to 8.9 cc.

Locust Bean Seed. The viscosity and filtration effects of this material are analogous to those of the Iranian gums. A greater quantity is required to produce the same result, as the active ingredient is not separated from the rest of the seed, and inert material is included.

FIG. 1. Effect of tragacanth gum No.11 20 per cent P-95 fresh water mud.

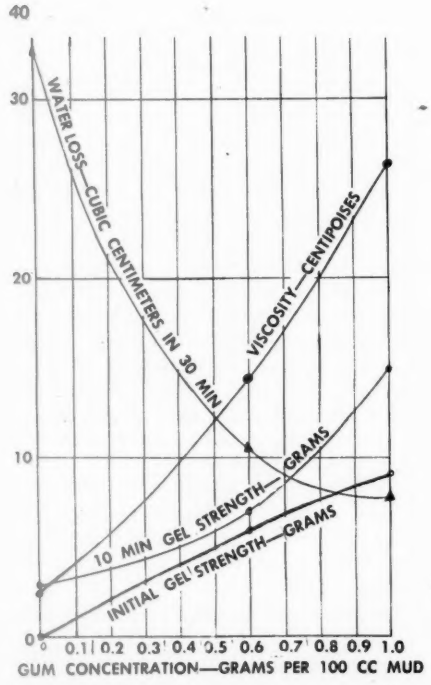


FIG. 2. Effect of gum ghatti on P-95 20 per cent fresh water mud.

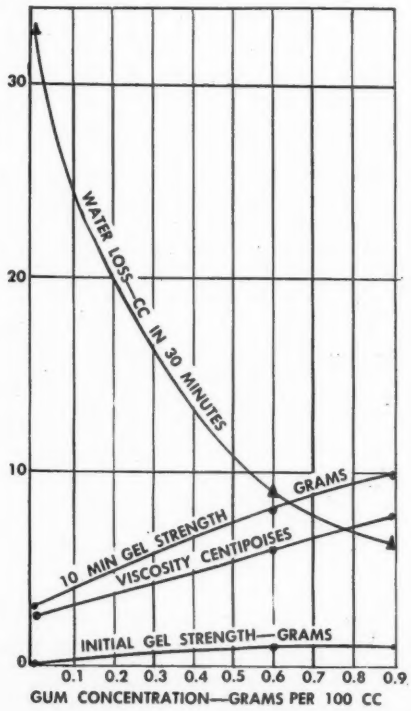
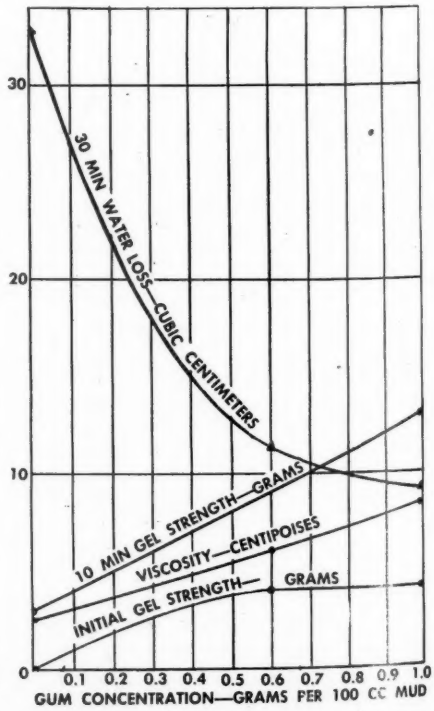


FIG. 3. Effect of gum shiras on 20 per cent P-95 fresh water mud.



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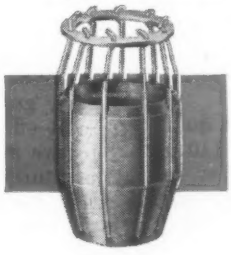

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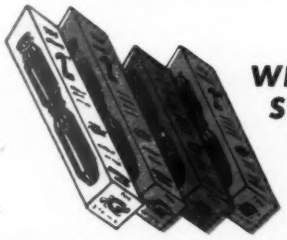

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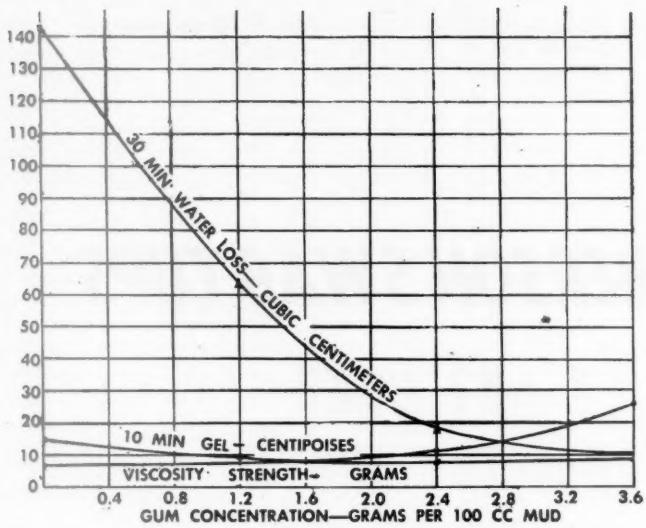
30 MIN. WATER LOSS—CUBIC CENTIMETERS
10 MIN GEL—CENTIPOISES
VISCOSITY STRENGTH—GRAMS
GUM CONCENTRATION—GRAMS PER 100 CC MUD

FIG. 4. Effect of locust bean seed on saturated brine mud (4 per cent Zeogel).

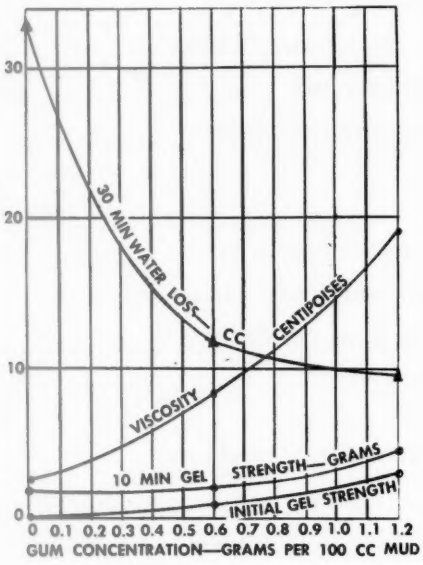

FIG. 5. Effect of quince seed on 20 per cent P-95 fresh water mud.

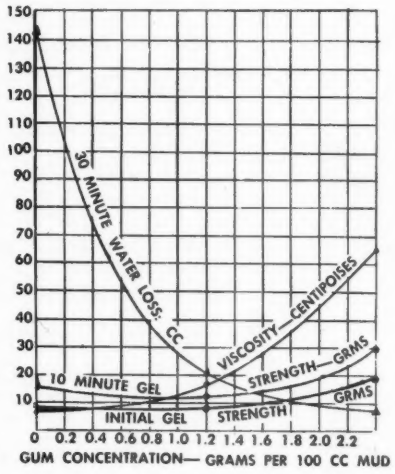

FIG. 6. Effect of quince seed on 4 per cent Zeogel saturated brine mud.

Fig. 4 shows the effect of locust bean seed on the viscosity, filtration and gel strength of saturated brine mud (4 per cent Zeogel). The addition of 2.4 per cent locust bean seed decreases the water loss from the original value of 143 cc. in 30 minutes to 18.9 cc. Mud containing 3.6 per cent of locust bean seed has a water loss of only 10.9 cc.

Quince Seed. Fig. 5 shows the effect of quince seed on fresh-water mud (20 per cent P-95 clay).

On addition of 0.6 per cent quince seed, the water loss decreases from an original filtration of 32.8 cc. in 30 minutes to 11.8 cc. Mud containing 1.2 per cent of this seed has a water loss of 9.6 cc. Viscosity rises from the original value of 2.5 centipoises to 19 centipoises.

Essentially the same behavior is shown on Fig. 6, where the effect of quince seed on saturated brine mud (4 per cent Zeogel) is indicated. A greater quantity is required to produce the same effect, however, as with the gums. This is probably due to the fact that active ingredient is not separated from the rest of the seed, and inert material is included.

The addition of 2.0 per cent of quince seed to 10 per cent brine mud (10 per cent Baroco clay) reduces water loss from 52 to 10.8 cc, while increasing viscosity from 4.7 to 15.5 centipoises.

Effect of Organic Colloids at 180 F

Considering the necessity of measuring filtration at the temperatures actually anticipated in the well, the comparative effectiveness of the different treatments at elevated temperature is included in the present work.

Due to the fact that the viscosity of the filtrate is diminished by increasing the temperature, it would be expected that increasing the temperature would have an adverse effect on filtration.

D. H. Larsen[6] has shown that the fluid loss is inversely proportional to the square root of the filtrate viscosity, if all the other properties of the filtrate and the cake remain unchanged. The accelerated flocculation at elevated temperatures, however, also contributes to the impairment in plastering properties, through alteration in the physical structure and compressibility of the mud sheath, leading to altered permeability of the cake. Furthermore, the effect of gums may be expected to vary with temperature. And, hence, a certain deviation exists between actual and calculated data, which can be expressed in per cent.

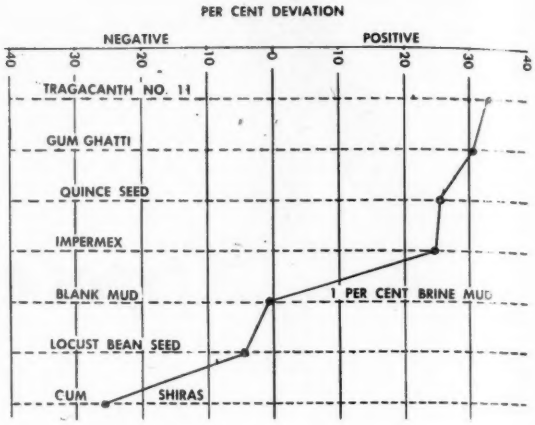

FIG. 7. Per cent deviation of water loss at 68 F—actual from calculated.

Results: Table 1 shows the effect of temperature on the water loss for the six best treatments used on 1 per cent brine mud (7.5 per cent Wilmington slough). Fig. 7 shows the per cent deviation of actual water loss from calculated values. In comparing the effectiveness of different treatments at high temperature, gum shiras was found to be the most effective, suggesting that its protective and coating power at high temperatures is of greater magnitude than that of other gums. The effectiveness of the treating agents is in the following order: (1) gum shiras, (2) locust bean seed, (3) Impermex, (4) quince seed, (5) gum ghatti, and (6) tragacanth gum. Of these, gum shiras and locust

TABLE 1. Variation in water loss with temperature of 1 per cent brine mud (7.5 per cent Wilmington Slough + 0.5 per cent Paraformaldehyde) treated with different organic colloids.

	Blank mud	Gum Ghatti 0.9%	Trag. 11 1.2%	Gum Shiras 1.7%	Impermex 1.8%	Quince seed 2.2%	Locust bean seed 3%
Water loss, cc 68 F	38.4	6.2	6.2	7.6	5.6	6.7	9.2
Water loss, cc 180 F	67.6	14.4	14.6	10.	12.4	15.1	15.6
Water loss, cc corrected from 180 F to 68 F for effect of filtrate viscosity	38.1	8.11	8.24	5.64	6.99	8.4	8.79
Deviation, actual from calculated, %	−0.78	+30.8	+32.9	−25.8	+24.8	+25.4	− 4.46

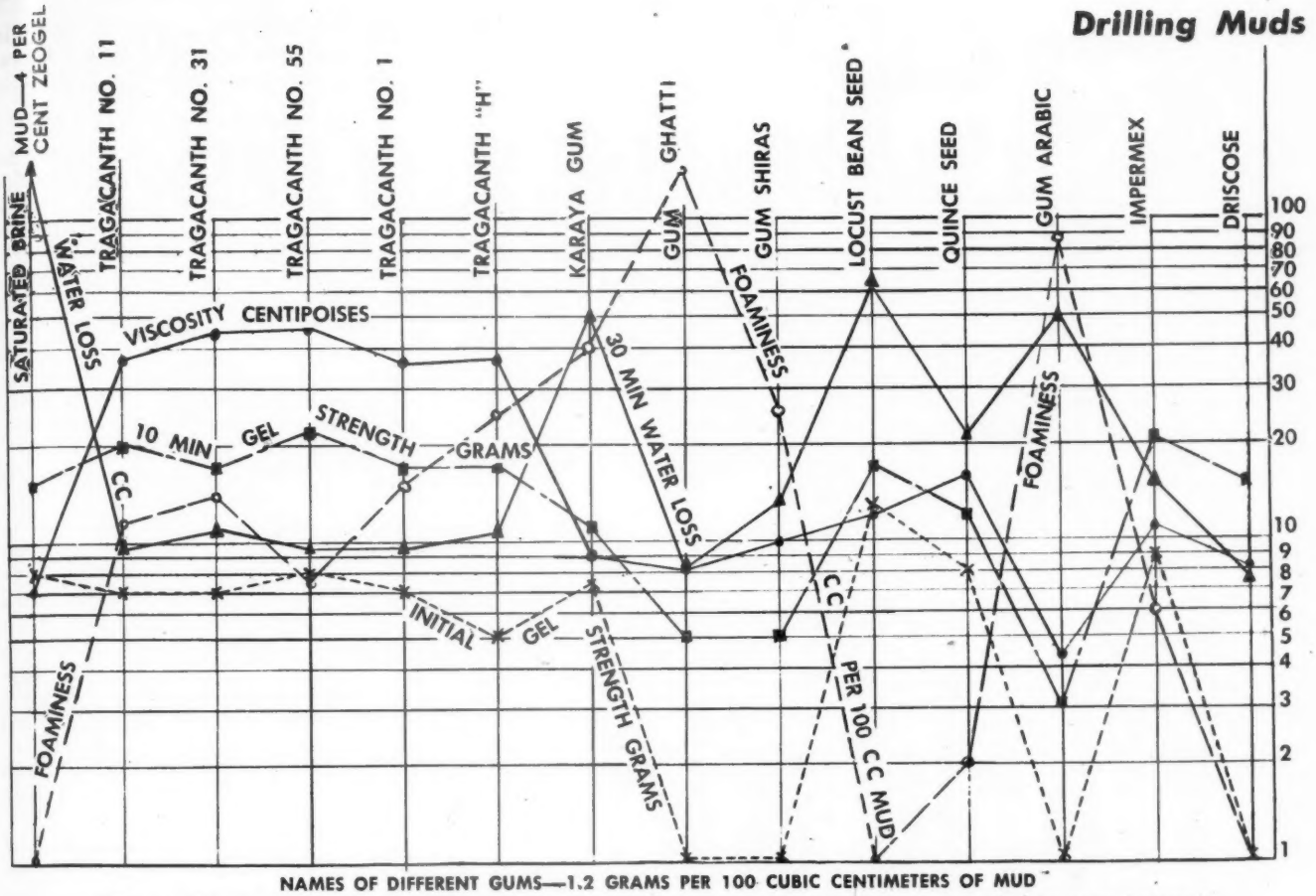

FIG. 8. Comparative study. Effect of various gums on saturated brine mud (4 per cent Zeogel).

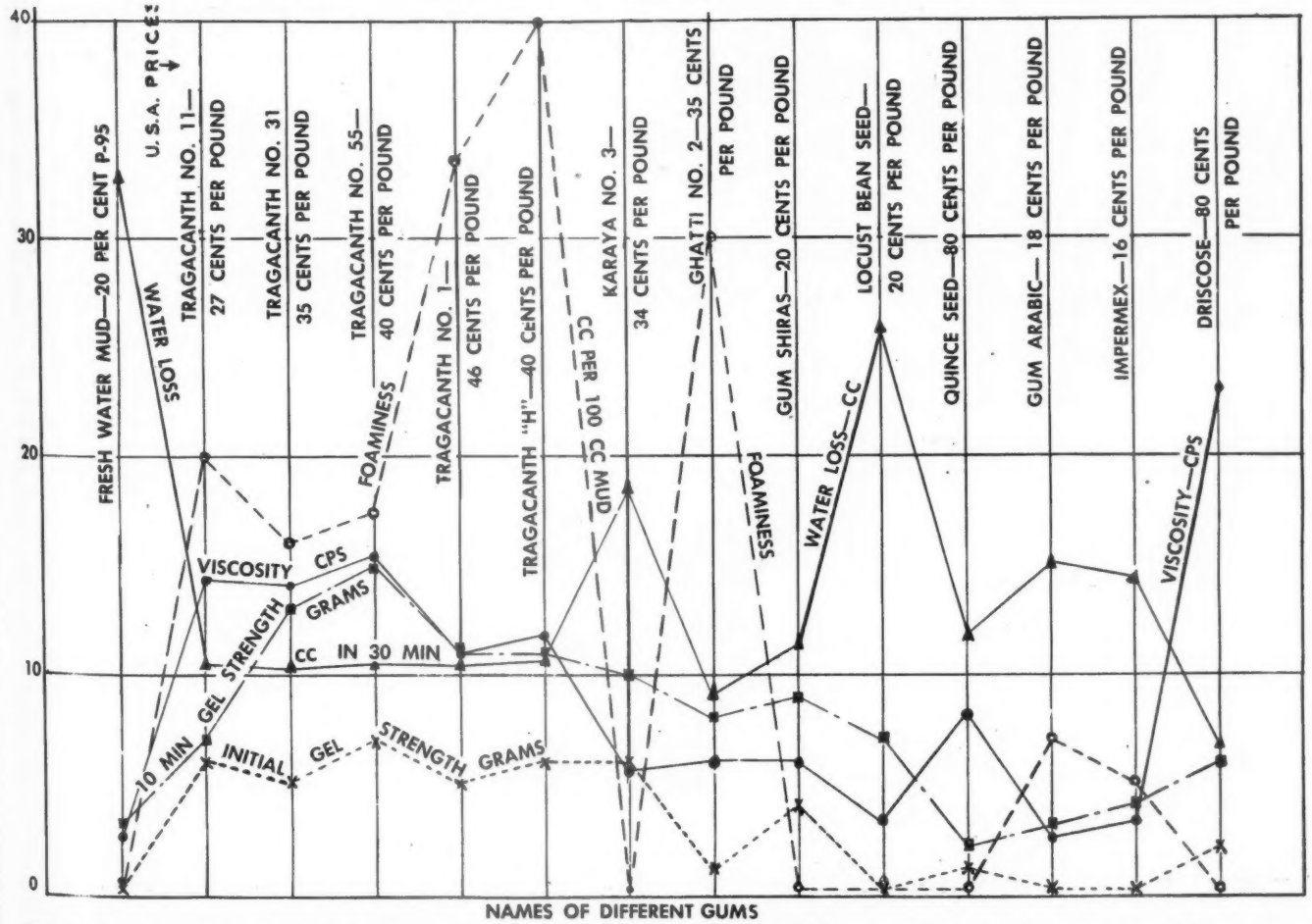

FIG. 9. Comparative study. Effective of various gum (0.6 grams per 100 cc. mud) on fresh water mud (20 per cent by weight P-95 clay + ½ per cent paraformaldehyde.

bean seed have a negative deviation. In each case the thickness of the cake was directly proportional to the water loss.

Comparative Study at 68 F

In order to determine which were the best treating agents, the Iranian colloids and, for comparison, Impermex, Driscose, and gum karaya, were tested on saturated-brine mud (4 per cent Zeogel) and fresh-water mud (20 per cent P-95). The concentration was constant in each case—1.2 per cent (1.2 grams per 100 cc mud) for saturated-brine mud and 0.6 per cent for the fresh-water mud. The results are indicated in Figs. 8 and 9, which show the variation of several properties on different treatments.

From the five different varieties of gum tragacanth, grade No. 11 is preferred due to its lower price (See Fig. 9), although other properties do not vary much with grade and price. In using gum tragacanth, however, careful control at the well would be necessary, due to a marked increase in viscosity with increasing concentration. The same is true of locust bean seed and quince seed. In this respect, gum shiras and ghatti compare favorably with Tragacanth, and do not show such a high increase in viscosity with increasing concentration.

The viscosity and filtration effects of locust bean seed and quince seed are analogous to those of the Iranian gums. A greater quantity, however, is required to produce the same effect as the active ingredient is not separated from the rest of the seed, and inert material is included. They could be used for drilling fluids in Iran, however, because of their low cost.

For further comparative study, the six best organic colloids have been tested on the following muds: (1) 10 per cent brine mud (10 per cent Baroco clay), (2) 1 per cent brine mud (7.5 per cent Wilmington Slough), and (3) high pH mud. The concentration of each colloid was so adjusted as to give roughly the same reduction in water loss, except in the case of treating the 10 per cent brine mud with Impermex, which was not very effective in this mud. From the relative amounts necessary to bring about the same water loss, the effectiveness and economy of various treatments can be judged. The results are indicated in Tables 2, 3, and 4.

Table 4 shows that various colloids can be substituted for starch in high pH, red lime base mud.

Conclusions

Iranian gums and gum bearing seeds improve markedly the filtration characteristics of fresh-water muds, salt-water muds, and high pH red lime-base muds. At elevated temperature, the effectiveness of gum shiras or locust bean seed is even greater, which indicates they should be excellent treating agents.

The effects of the gums and seeds are similar to those of starch, while higher concentrations of starch usually are necessary to obtain equivalent results.

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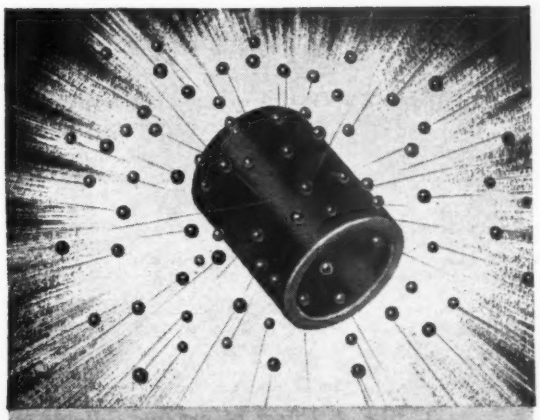

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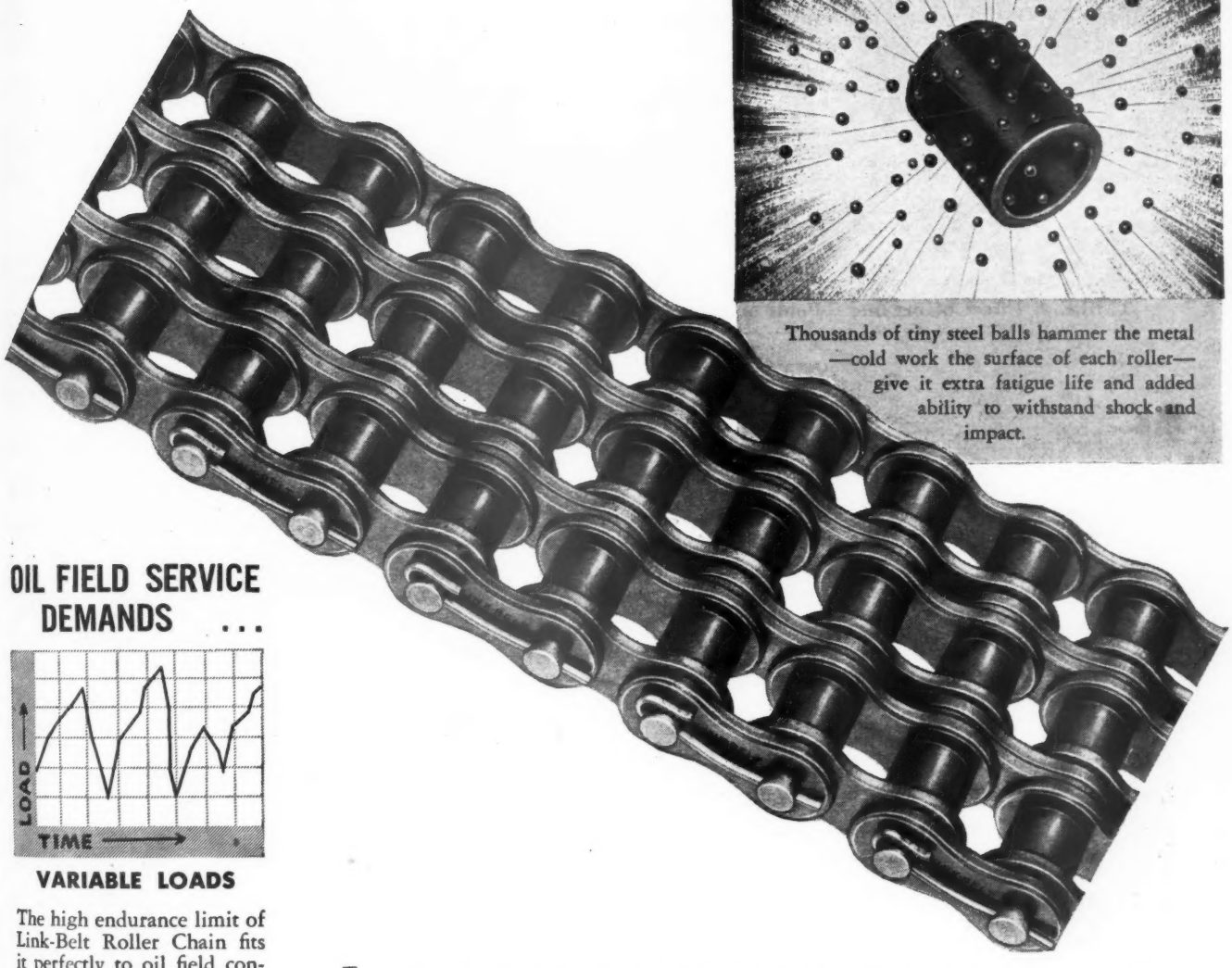

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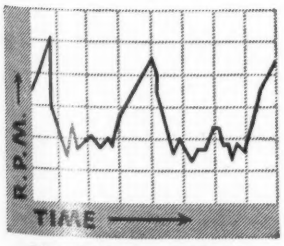

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TABLE 2. Effect of organic colloids on 10 per cent brine mud at 68 F.

Test	Blank mud	Gum ghatti 1%	Tragacanth No. 11 1.2%	Gum shiras 1.6%	Impermex 1.7%	Quince seed 2%	Locust bean seed 3%
Viscosity, cps	4.7	5.9	51	10.1	6.1	15.5	100
Initial gel strength, grms	17	0	15	6	9	7	7
Ten minute gel strength, grms	22	2	27	26	23	11	12
Water Loss, cc	52	5.5	6.7	8.9	35.2	10.8	6.6
Cake thickness, 1/64 in	10	1	1	1.1	9	1.1	1
Foaminess, cc/100 cc. mud	0	15	15	4	4	3	1

Note: The mud was composed of 10 per cent Baroco clay in 10 per cent brine solution.

TABLE 3. Effect of organic colloids on 1 per cent brine mud at 68 F.

Test	Blank mud	Gum ghatti 0.9%	Tragacanth No. 11 1.2%	Gum shiras 1.7%	Impermex 1.8%	Quince seed 2.2%	Locust bean seed 3%
Viscosity, cps	2	4.4	46.5	7.4	4.7	28.3	9.8
Initial gel strength, grms	2	0	22	8	8	4	2
Ten minute gel strength, grms	6	4	45	13	19	8	3
Water Loss, cc	38.4	6.2	6.2	7.6	5.6	6.7	9.2
Cake thickness, 1/64 in	2.5	0.70	0.6	1	0.5	0.9	0.5
Foaminess, cc/100 cc mud	0	13	32	2	5	3	25

Note: The mud was composed of 7.5 per cent Wilmington Slough clay and 0.5 per cent Paraformaldehyde in 1 per cent brine solution.

TABLE 4. Effect of organic colloids on high pH mud at 68 F.

Test	Blank mud	Gum ghatti 2.1%	Tragacanth No. 11 1.2%	Gum shiras 2%	Impermex 3.86%	Quince seed 1.5%	Locust bean seed 1.5%
Viscosity, cps	3	12	29	20	24	34.5	19
Initial gel strength, grms	0	2	4	4	1	8	1
Ten minute gel strength, grms	2	4	5.5	6	3	27	27
Water loss, cc	19	2.4	4.4	3.8	1.9	5.6	6.9
Cake thickness, 1/64 in	5	1	1.1	1	0.9	2	2.5
Foaminess, cc/100 cc mud	0	6	20	0	7	11	7.5
pH	12.5	12.95	12.2	12.35	12.8	12.2	12.2

Note: The composition of the red lime-base mud was as follows: 35 per cent P-95 clay, 3 lb per barrel caustic, 3 lb per barrel Quebracho, 2 lb per barrel lime.

Upon consideration of the prices in the United States of the natural organic colloids, as indicated in Fig. 9, it is apparent that some of the Iranian gums and seeds would be quite economical. The prices would be reduced considerably, however, if the gums or seeds were used on a large scale. As a consequence, the advisability of increasing the use of these materials in treating drilling fluids in the United States should be thoroughly investigated. In addition, there is little doubt as to the increase in their use in the Near East, where the price of starch is greater than that of the other treating agents.

Acknowledgment

The investigators are greatly indebted to D. H. Larsen of Baroid Sales Division, whose help was invaluable in carrying this work to completion.

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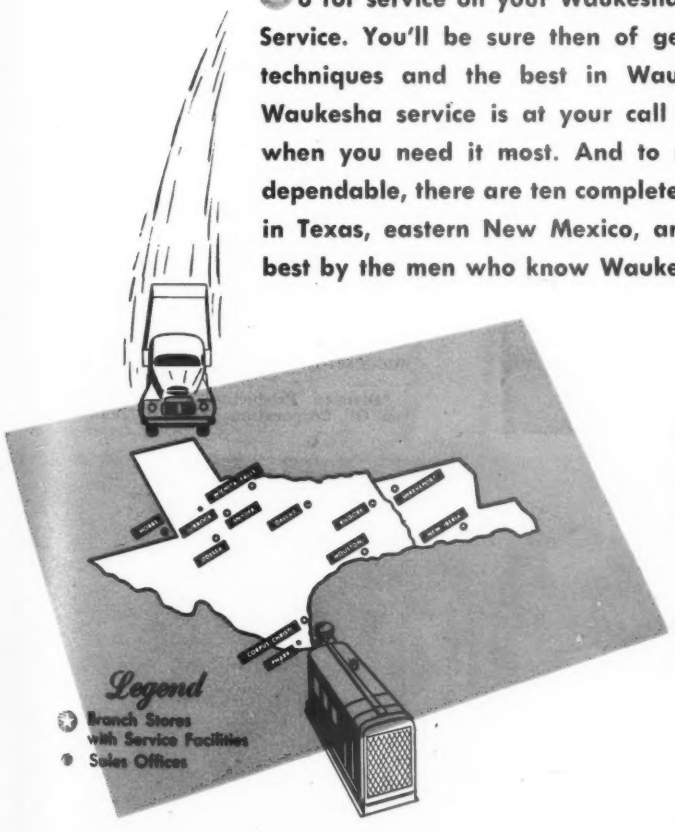

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Installation of Pumping Units

Foundation construction shows another method of saving both expense and time

JACK L. COULSON*

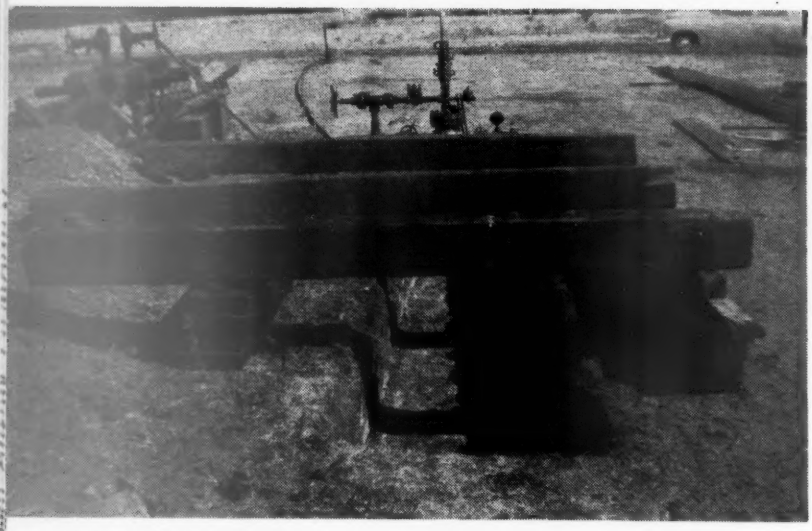


FIG. 2. Timbers in place for supporting pumping unit.

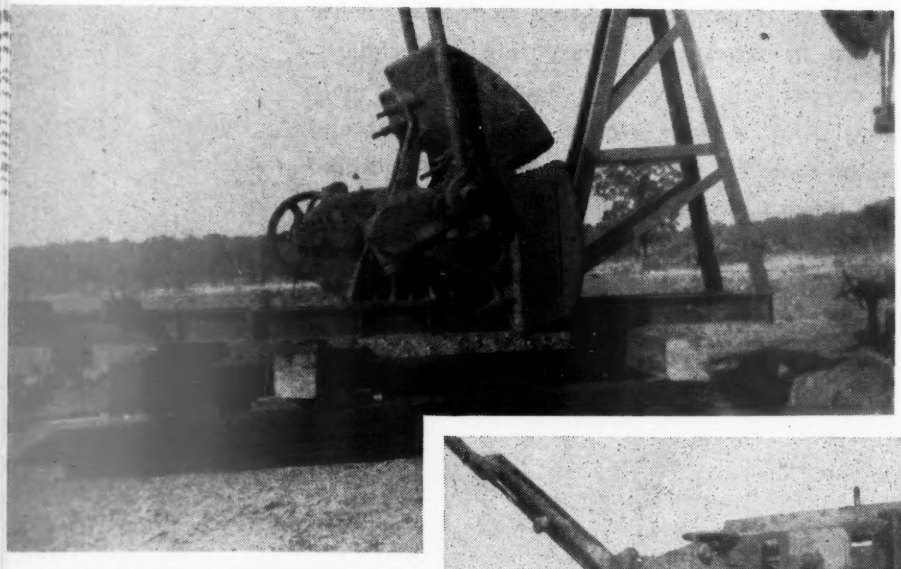


FIG. 3. Above, pumping unit on timbers ready for legs to be bolted on.

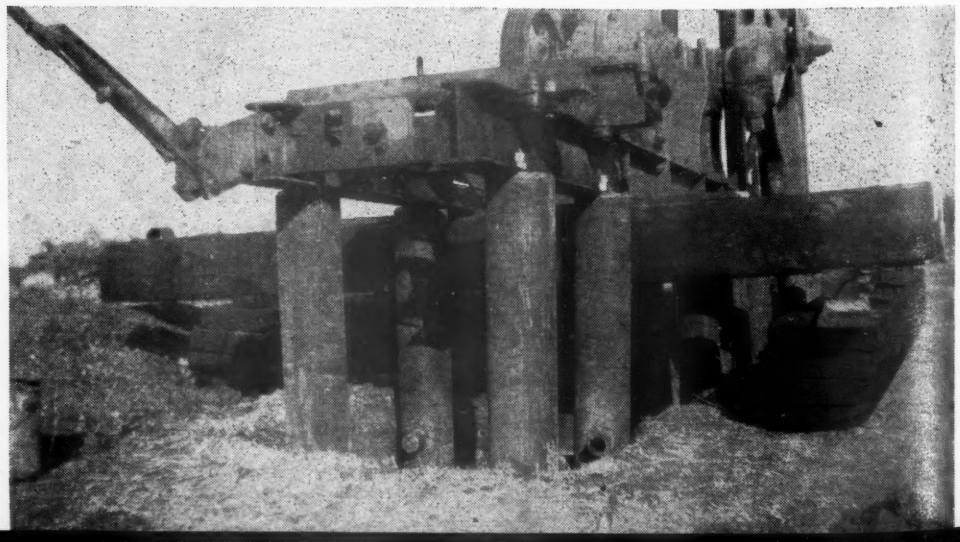
FIG. 4. Pipe legs attached ready for pouring concrete.

FIG. 1. Excavation required for 80,000 in.-lb pumping unit.

THERE have been numerous methods of setting pumping units, always with the idea in mind to reduce costs as well as having a substantial foundation for the proper operation of the pumping unit.

There has been the ever important requirement from the operating standpoint for the production of oil from the well either by flowing or pumping. Since the majority of wells are eventually pumped, the essence of speed in placing the well on the pump and maintaining production has been a problem confronting the majority of the production men. With this idea in mind as well as reduction of installation costs, a new method of installation of pumping units has been tried and found to be very successful. It should be mentioned here

*Division Production Superintendent, Warren Oil Corporation, Abilene, Texas.



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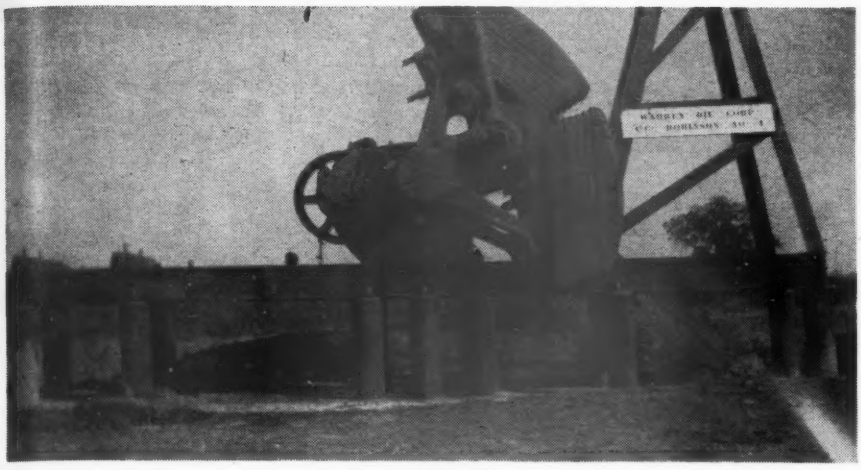


FIG. 5. Unit resting on legs anchored in concrete.

that some of the fundamentals of setting pumping units are still required to be as exacting in this method as that of others. These fundamentals deal with proper bearing area, alignment of the unit, proper spacing of the unit from the well and the like.

Fig. 1 shows a typical excavation required for the concrete of the pumping unit foundation. These foundation excavations are dug approximately the same shape as the foundation plan view for most all types of units. Depending upon the soil conditions, dovetail or footing can be cut at the bottom for better anchor or bearing surface, whichever is required. After the excavation is completed, timbers are placed across the excavation as shown in Fig. 2. These timbers are used to support the unit the proper clearance above ground level. It should be noted here, that units equipped with subbases require less leg height above ground level. The nicer looking of the installations are those units that have subbases. Fig. 2 shows a pumping unit without subbases, thereby requiring more ground clearance or longer legs.

Fig. 3 shows the unit setting on the sills over the excavation waiting for the legs to be bolted on before pouring the concrete.

Fig. 4 shows the legs bolted to the unit. At this point of installation, reinforcing rods are placed around the legs or if preferred junk pipe can be welded between the legs to make a more rigid structure. Experience shows, however, that this extra welded reinforcement has not been necessary. The unit can now be leveled and positioned before pouring the concrete.

Fig. 5 shows the unit set and concrete poured, supporting timbers have been removed. Normally if the unit is set in an area that will be cultivated at some later date, the idea is to pour the concrete to within 8 in. of ground level. This is suggested so that when the unit is moved, the legs are cut off at concrete level and covered over, and will not require the moving of the block nor will it interfere with cultivation.

Fig. 6 shows the unit in operation after the concrete has hardened. This entire operation of setting the unit, installing the engine, and putting the unit in operation has required two days. Once the unit is in operation, a cranking platform is constructed of expanded metal screen. This serves as a non-skid platform that allows all dirt, etc., to fall to the ground. This aids in keeping the unit area clean. Other safety apparatus and guards can be installed in accordance with the ideas of individual companies.

Fig. 7 shows typical construction of the legs used under the pumping units. These could be modified to fit requirements; however, these have been found to be very satisfactory. It has been general practice to use 7-in. junk casing for 80,000-in.-lb size units and 5½-in. casing on units under this rating. Machine bolts of 1¼ in. and 1⅛ in. size are used and are welded in the top casings of the unit legs. The legs are spaced so that they are placed at the most heavily loaded points.

There are a number of advantages of mounting the pumping unit on pipe leg supports, such as:

(1) No wooden forms are necessary.

(2) Unit actually in place for leveling and positioning.

(3) That this type of installation can be used most any place.

(4) Time saved by not having finished work or grouting of block.

(5) Easy to keep clean.

(6) Lower cost of installation.

(7) Little labor or expense is required at abandonment of the well.

Regardless of the type of installation, it is still important that proper alignment be made and that substantial footing is used in order that failure will not occur. * * *

FIG. 7. View of pipe legs. Two inches clear through leg. Bottoms welded shut by use of plate.

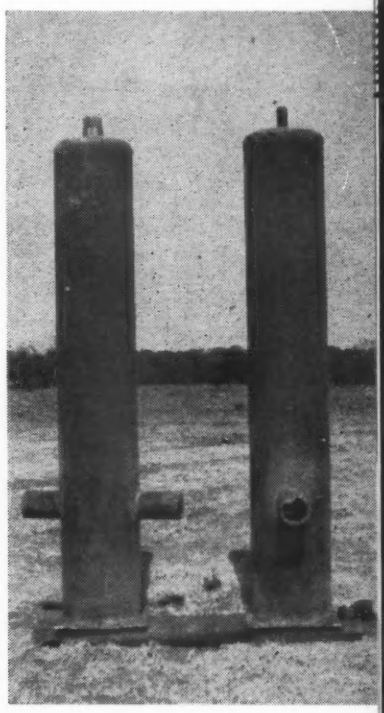
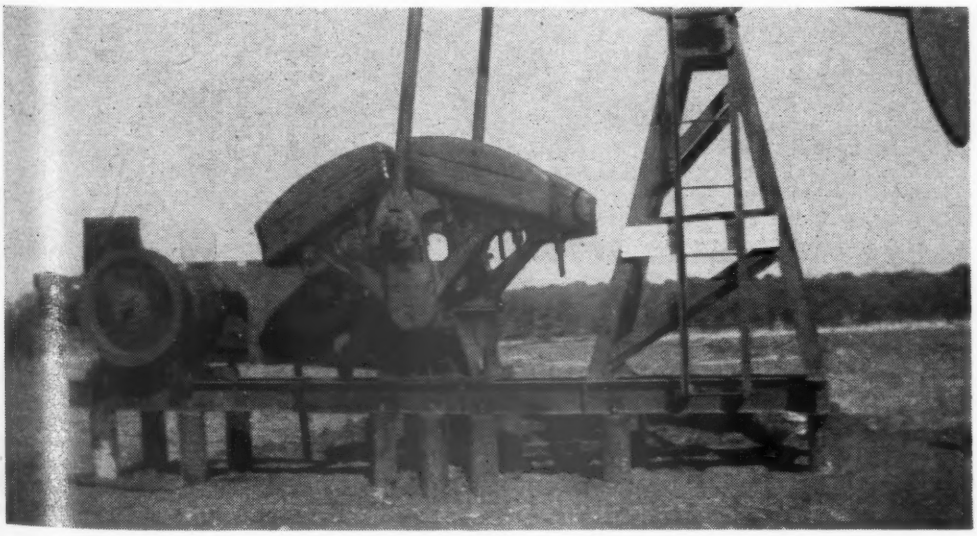


FIG. 6. Unit in operation. Dirt fill is shaken over concrete base.



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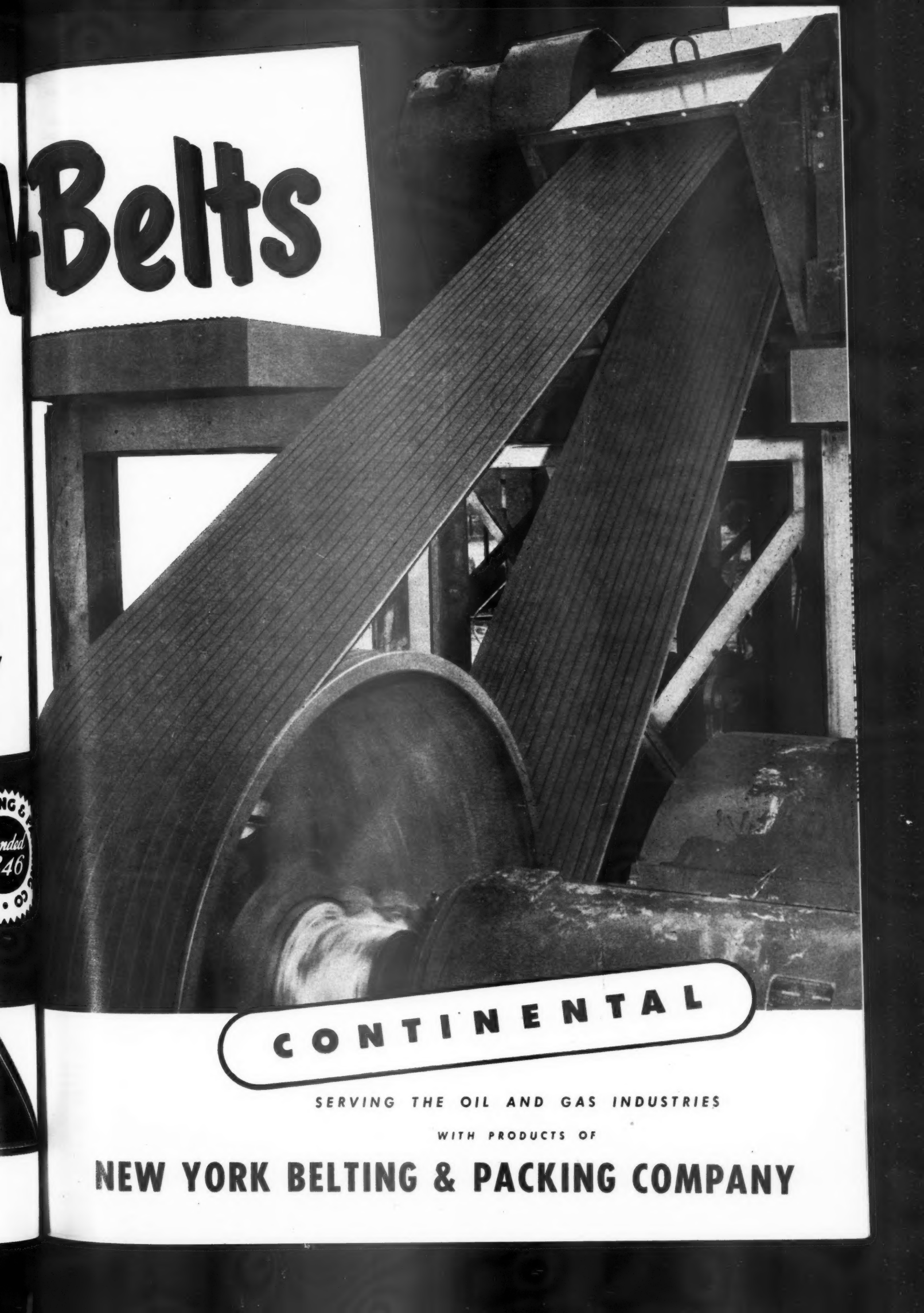

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FIG. 1. Distribution of French sedimentary basins.

Petroleum Exploration and Development in France†

Discovery of Lacq field in 1949 marked a new intensified search for oil and gas

DR. J. DUPOUY-CAMET*

BOTH years 1950 and 1951 have been marked by considerable development in the intensity of petroleum search in continental France. A beginning has been made upon the study of unexplored or partially explored sedimentary basins: (1) Alsace Valley where, in addition to the old Pechelbronn oil field, 250,000 acres of land have been leased and a new company created; (2) valley of the river Saone, Jura, Savoie, Provence, where 3,243,000 acres are under exploration by the same government company (R.A.P.) which already operates St. Marcet gas field, in the foothills of the Pyrenees; (3) Paris basin, where geological work is in its beginning; (4) lower valley of the Rhone river (Camargue), intensively drilled; (5) the Aquitaine Basin, in the northern part of which 4,356,000 acres of land has been acquired by the S. F. de P. (Jersey Standard, Gulf, Atlantic combined).

The distribution of French sedimentary basins, filled with Mesozoic and Cenozoic sediments, between Hercynian Paleozoic massifs (Central Massif, Armorican Massif, Ardennes . . . etc.), is shown in Fig. 1. In the southeast, the French Alps, in the southwest, the Pyrenees, comprise intensely folded sedimentary chains that do not seem to offer favorable conditions for oil exploration. In the extreme north of France, the coal basin belongs to a branch of the Variscan system with intensely folded Carboniferous rocks. Between these various tectonic elements there are basins where oil prospecting seems promising.

The Paris basin, the broadest of all, shows no indications of oil. But, the study of structures, stratigraphic traps and unconformities, is just beginning. The Aquitaine basin is the most interesting one by virtue of numerous oil seepages, asphaltic limestones, tarsands, and sulfurous and oily springs, especially in its southwestern part; of the great thickness of the sedimentary sequence (locally over 30,000 ft); and of important subsidence indicated by the Cretaceous Flysch that fills a large trough along the northern front of the Pyrenees. In this trough was discovered, first, in 1939, the St. Marcet gas field; later, in 1949, the Lacq oil field, at a position where Flysch facies of the trough are changing northward into limestone facies of the epicontinental shelf. The exploration of the shelf has failed to find up to now any commercial production, but it steadily proceeds. In the Languedoc basin, where the small Gabian oil field, discovered in 1924, is now exhausted, oil problems are particularly the exploration of the Triassic series, whereas, farther east, in the Rhone river delta and Camargue basin, which form the northern border of a broad basin, largely covered by waters of the Mediterranean Sea, there are oil shows in Oligocene and Miocene sediments. The Rhone river, Saone river, Pechelbronn and Limagne basins, are much narrower. For more detailed information, please refer to a paper by H. de Cizancourt in the "Science of Petroleum."[1]

The outstanding event in French petroleum exploration was the discovery of Lacq oil field, in December 1949, in

[1]H. de Cizancourt, France, Petroleum, Vol. VI, Pt I—57. In course of publication.

Table 1

Structures	Dry	Gas	Gas and oil	Total	Max. depth (feet)	Remarks
St. Marcet	4	13	2	19	9,351	Gas field.
Plagne	3	1	0	4	10,663	Gas but no commercial production
Proupiary	2	2	0	4	8,941	Gas but no commercial production
St. Martory	2	0	0	2	9,948	Gas shows
Aurignac	3	0	0	3	9,771	Dry
Gensac	3	0	0	3	10,138	Oil shows
Richou	2	0	0	2	8,045	Gas shows
Castillon	1	0	0	1	9,157	Dry
Puymaurin	1	0	0	1	13,368	Dry
Total	21	16	2	39		

†Presented before the American Association for the Advancement of Science in Philadelphia, Pennsylvania, December 28, 1951.

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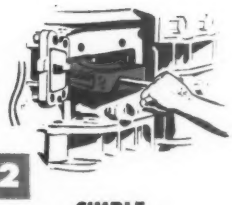

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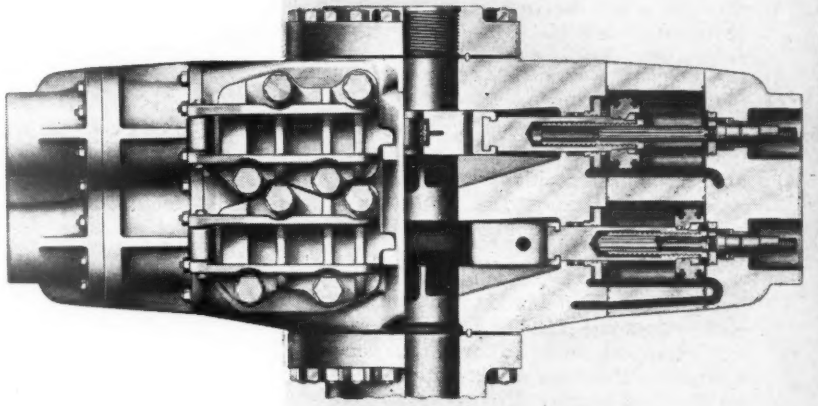

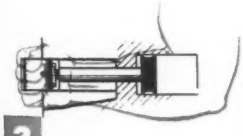

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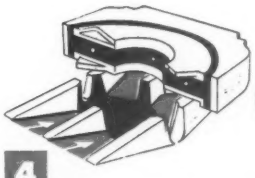

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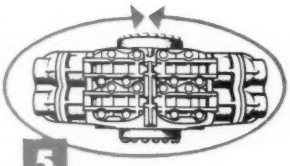

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the southern part of the Aquitaine basin. Another significant development is the steady increase of gas and condensate production in St. Marcet gas field.

AQUITAINE BASIN

Regie Autonome des Petroles—(RAP) Fig. 1-1

At the end of 1949, thirty-nine wells had been completed by RAP on the Cretaceous anticlines of the so-called "Petites Pyrenees" area (see Table 1); most of them reach 6000 ft. Since the beginning of prospecting in 1938, 394,625 ft had been drilled and production of the St. Marcet gas field reached 8050 million cubic feet during the year 1949 (cumulative production: 32,344 million cubic feet).

St. Marcet gas field.[2] This gas field, so very important in French production, was discovered on July 14, 1939, when a wildcat, St. Marcet No. 1, drilled through a gas horizon in a Senonian sedimentary breccia (6.35 million cubic ft per day, 2060 psi); it also encountered, at about 6000 ft, two oil horizons in a Jurassic dolomite. Out of 19 wells drilled, 15 have been completed as producers; among them 10 have at favorable structural positions been put into production. At the end of 1949, only 4 wells had yielded about 79 per cent of the field production.

This field is of the condensate type, being a Senonian breccia covering an eroded anticline made of Triassic Jurassic limestone, and Lower Cretaceous sediments. Pressure decline appears to be slow and regular. High porosity and permeability of the breccia reservoir ensures a uniform pressure in all the wells. A little oil production was intermittently established in two wells, from Middle Jurassic dolomite, at a depth lower than the gas reservoir. Fifteen thousand seven hundred barrels of paraffinic, 31 API oil, were produced with a GOR of 32,000 in St. Marcet No. 1 and of 19,000 in St. Marcet No. 11. St. Marcet No. 3 was also completed as a gas producer, but in Liassic dolomite.

At the present time St. Marcet gas field development is coming to an end, at least with respect to the Senonian breccia reservoir.[3]

Other Structures. No commercial production could be established on the structures in the vicinity of St. Marcet gas field, even on those which, as St. Martory and Proupiary domes, are situated on the same anticline as St. Marcet. Very likely, the erosion of a shoal such as gave rise to the St. Marcet Upper Cretaceous breccia, has been a relatively localized phenomenon. Gas and high pressures have been encountered on the Proupiary and Plagne structures, and a few wells have locally yielded a little gas production, but the equivalent of the St. Marcet conglomeratic horizon has appeared to be dense and to have a very low porosity.

Outside of the Flysch trough of subsidence, on the continental shelf, Puymaurin No. 1 wildcat has encountered some oil and gas shows in the Jurassic. In the transition zone, north and northwest of St. Marcet, 3 wells have been drilled on Aurignac anticline without any significant shows. Well No. 1 was stopped in a thick basaltic outflow at the base of Upper Cretaceous Flysch. On Gensac anticline, a local facies of the Lower Flysch gave rise to the development of a very thick (3000 ft) sandstone, which could comprise a first-class reservoir. In Gensac No. 1 well, this sandstone bled oil from the upper 60 ft, although no commercial production could be established. In two other wells, this sandstone has been encountered filled with salt water.

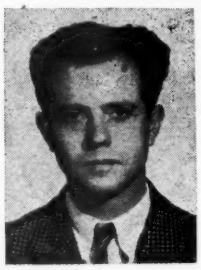
Development in 1950 and 1951. Six heavy rigs and one geological rig were operated by RAP in 1950 and 1951. Surface geological studies are nearly completed, with the exception of some detailed work on the north flank of the Pyrenees. Some 10 deep tests have been completed, among them 5 on new structures, none of which proved productive. Buried structures, discovered by geophysical methods, have been studied by 8 geological holes (Table 2).

St. Marcet No. 21, on the southwest flank of the anticline, was stopped while still in the Flysch, which had strong dips. Gas production increased in 1950, 8651 million cubic ft, and simultaneously, that of condensate, as follows (See Fig. 2):

Gasoline	13,255	tons
Butane	6,738	tons
Propane	2,476	tons
Total	22,469	tons = 200,600 bbl

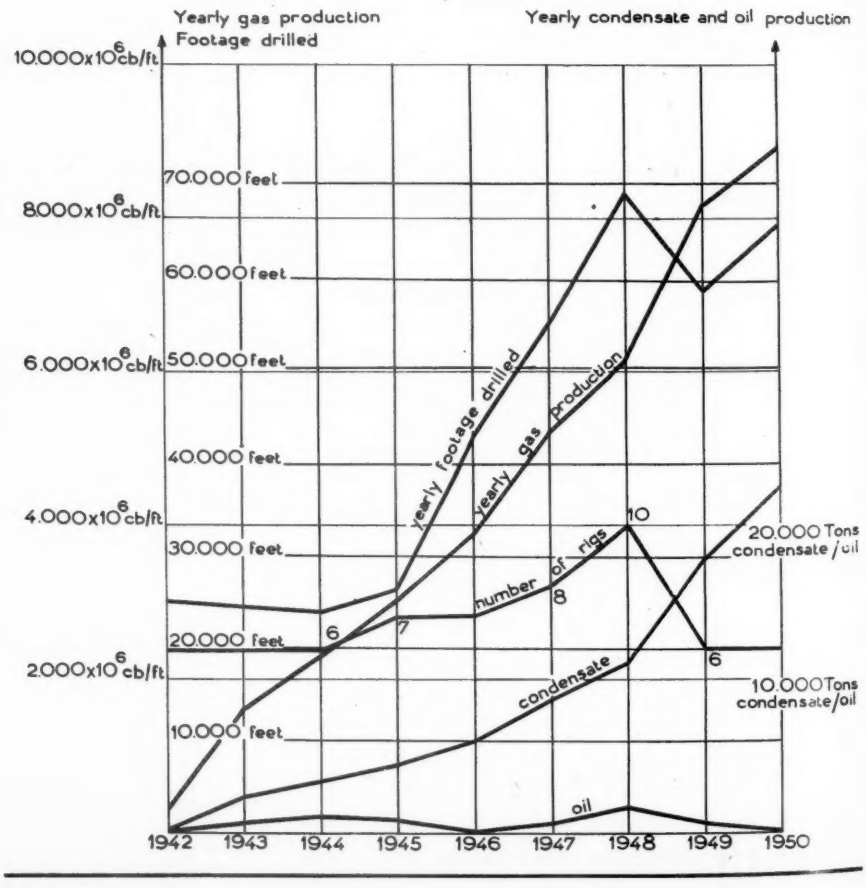
Two wells have been located on the eastern and western end of Plagne anticline, the central part of which has been

The Author



Jacques Dupouy-Camet was graduated a mining engineer in 1943 and worked as a resident geologist with the Societe Nationale des Petroles d'Aquitaine (SNPA) operating in the southwest of France. He made a special study of tectonic behavior of salt occurrence and paleogeography of the Aquitaine basin. Later he joined the Compagnie Francaise des Petroles geological department. He was graduated, in 1949, from the University of Paris with the degree of Doctor in Natural Sciences. He worked for Compagnie Française des Pétroles in France and Vénézuéla.

FIG. 2. Footage drilled and production in St. Marcet gas field.



[2]D. Schneegans. "Gas bearing structures of Southern France." Bull. Amer. Assoc. Petrol. Geol. Vol. 32, No. 2 (Feb. 1948), pp 198-214.

[3]F. de Boulard. "L'exploitation du gisement de gaz naturel de Saint-Marcet." ((Exploitation of Saint-Marcet natural gas field). Proceedings of the third World Petroleum Congress—Section 2—Drilling and Production—1951—pp 701-720.

previously explored. In the western well, Plagne No. 5, structural complications and very steep dips caused the disappearance of the Lower Flysch breccia. In spite of the exploration of the entire Liassic (dolomites, limestones, and breccias), no commercial production could be established, though numerous gas shows had been encountered in the Cretaceous. Salt-bearing Keuper has been reached at 10,220 ft and the well stopped shortly below. There were some gas shows in the eastern well, Plagne No. 6.

On Proupiary anticline, well No. 5, located in the eastern central portion, encountered some sandy horizons in the Upper Flysch, and yielded a little gas: 560,000 cu ft per day from the most productive horizons. Middle Jurassic dolomites were reached under Upper Cretaceous and the well stopped in marly Liassic at about 7000 ft. On Gensac anticline, well No. 4 reached Keuper at about 5000 ft.

Five new structures have been explored deeply: Lespugne, Labarthe, Lieoux, Mondilhan, and Muret. Oil shows were minor, especially owing to lack of porosity. Paleozoic was reached on Lieoux anticline, Jurassic on Mondilhan and Triassic on Lespugne beneath Lower Cretaceous. Muret exploration is a very interesting problem. There is a gravity and seismic anomaly which seems to represent the extension, under the Aquitaine basin, of the so-called "Montagne Noire" Paleozoic basement. This basement comprising Permian sandstones over-lying Silurian shales, was reached at about 1300 ft in a shallow geological test, Muret No. 101. The search for stratigraphic wedges of various stages, from Jurassic to Upper Cretaceous, lapping up onto the southern border of this Paleozoic nose, has been undertaken by deep test Muret No. 1, spudded November 30, 1950. This well, beneath 6224 ft of molassic sediments, was drilled through Eocene, Cretaceous, then Liassic, before entering Keuper. In the very thin Cretaceous, some porous Upper Cretaceous sandstones produced mainly salt water with a little gas. The study of this difficult but promising problem continues, however.

Besides, RAP is drilling Bordères 1 and St-Médard 2, on Bordères and St-Médard anticlines, in the eastern half of SNPA concession, according to a joint agreement RAP-SNPA.

Between 1950 and 1955, about 20 wells totaling 200,000 ft are planned to complete exploration in this area. Additional occurrences of the already known reservoirs, St. Marcet conglomerate and Gensac sandstone, will be prospected along the entire northern Pyrenean front.

Societe Nationale des Petroles D'Aquitaine (SNPA) Fig. 1-2

Researches anterior to 1950. To the end of 1949, 31 wells had been completed by SNPA, on various anticlines or salt-dome flanks, many of them drilled to more than 10,000 ft. In 1942, exploration began in the Flysch subsidence trough, on Dreuilhe anticline, the eastern analog of the Cretaceous anticline of St. Marcet area, and continued at Tréziers, on Cretaceous stratigraphic wedges transgressive upon the Paleozoic basement of the "Montagne Noire." Development proceeded gradually on the outcropping and geophysically evident anticlines of the limestone epicontinental shelf, or on flanks of salt-domes piercing the southwestern part of the Aquitaine basin. Since the beginning of exploration, 165,146 ft had been drilled. Wells over 3000 ft totaled 86,248 ft, as shown in Table 3.

Table 2

Structures	Completed	Results	Max. depth
St. Marcet	1	Dry	6,408
Plagne	2	Dry	10,418
Proupiary	1	Gas shows	6,995
Gensac	1	Dry	10,138
Lespugne	1	Dry	13,314
Labarthe	1	Little gas show	5,433
Muret	1	Dry	8,957
Lieoux	1	Dry	6,529
Mondilhan	1	Dry	10,368
Total	10		

This search had given no commercial results, in spite of frequent shows noticed in course of drilling, and even a little production, amounting to 2000 bbl of 24 API oil from Garlin 1 well, between 6233 and 6430 ft, in a Liassic conglomerate capping a deep-seated Triassic salt plug. Great structural complexity and capricious behavior of Triassic evaporites made very difficult the exploration of the basin.

Very fortunately, in December 1949, the Lacq No. 1 well encountered 150 ft of limestone impregnated with 25.5 API oil between 2100 ft and 2280 ft, in an Upper Cretaceous limestone. This is situated on a subordinate anticline discovered by seismic survey on the eastern flank of Ste. Suzanne anticline, where numerous asphalt seepages had long been known. The first test showed a potential production of 180 bbl per day. In 1950 and 1951 Lacq oil field has proved to be the most important field either in metropolitan France or overseas French territories.

Development in 1950 and 1951. Four heavy rigs and three medium sized rigs are operated by SNPA in development of Lacq oil field and in exploration. Activity is increasing steadily, as shown in Table 4.

Because of failure of exploration on the epicontinental shelf, and also because of the happy results obtained at Lacq, on the border of the Flysch trough, SNPA gave emphasis to the gravimetric and seismic exploration of structures along the north Pyrenean front, in the vicinity of Pau; this area is in the transition zone between Flysch and shelf facies in the Upper Cretaceous (Pau, Soumoulou).

Lacq Oil Field. The Lacq oil field has been intensely developed in 1950 and 1951. Continually increasing production rose to a monthly 146,200 bbl in December, 1951, with 19 productive wells, among them 14 producers (4716 bbl per day). These wells are good producers, some of them being tested at 1000 bbl per day, production being strictly controlled to avoid waterconing. (See Table 5).

Lacq crude is of mixed base type, paraffinic, naphthenic, 21.5 API, 3.89 per cent sulfur, 3.1 per cent paraffin. The oil is undersaturated at reservoir conditions and GOR is not over 45. The field is obviously under a strong water-drive; its pressure, at the reference level—1722 ft, is 867 psi. At the end

Table 3

Structures	Number of wells	Max. depth	Footage	Stage reached	Results
Dreuilhe	2	6,746	12,996	Upper Cretaceous Flysch	Dry
Treziers	2	5,433	8,790	Paleozoic basement	Dry
Garlin	4	10,394	32,931	Diapiric Triassic under Jurassic	Well No. 1 yielded 2,000/ Bbl 24 API oil from Liassic breccia
Antin	1	8,524	8,524	Diapiric Triassic under Lower Senonian	Dry
St. Medard	1	10,092	10,092	Diapiric Triassic under Aptian	Gas and salt water in the Triassic
Audignon	2	9,673	16,930	Diapiric Triassic under Lower Liassic	70 Bbl 22 API oil in the Liassic
Bastennes-Gaujacq	2	13,655	25,503	Diapiric Triassic under Aptian	Oil show in Aptian
Louer	1	3,291	3,291	Albian	Dry
Total	15		86,248		No commercial production

Table 4

Year	Footage	Wells completed	Dry	Oil	Production (bbl)	Number of rigs		
						Heavy	Medium	Total
1947	41,214	9	9	0	0	5	2	7
1948	27,075	6	6	0	0	6	2	8
1949	55,230	8	7	1	0	6	2	8
1950	64,080	13	6	7	444,871	5	2	7
1951	104,660	30	19	11	1,617,500	4	3	7

Table 5

Year	No. of wells	Productive	Wet	Producers		Production (bbl)	
				Flowing	Pumping		
1949	1	1	0	0	1	0	
1950	11	7	4	5	0	444,871	1 observation well 1 deep test
1951	24	11	13	8	0	1,617,500	3 observation wells
Total	36	19	17	13	1	2,062,300	

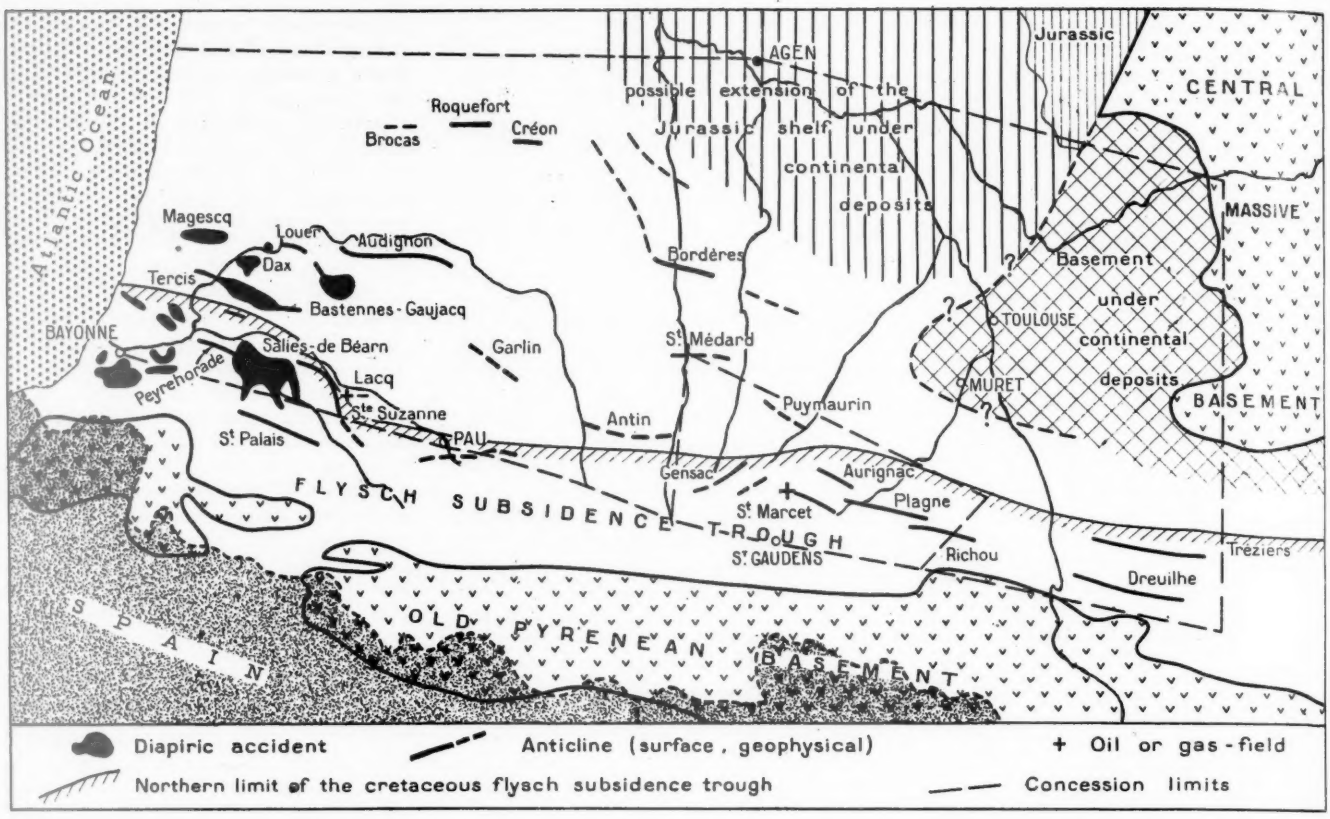


FIG. 3. Structural sketch of the southern part of Aquitaine Basin in southern France.

of 1950, reserves were provisionally estimated by volumetric methods at 20,000,000 bbl, though they seem, at the end of 1951, low estimated. Development is in progress with three rigs. The extension of the field is not entirely known.

Exploration. Exploration of the continental shelf has not been very active these last two years, the failures of the preceding years and the discovery at Lacq having displaced the area of interest towards the Flysch trough along the Pyrenean range. Well No. 1, on Roquefort anticline, however, explored Jurassic and Cretaceous and drilled Triassic series from 5741 ft to 10,698 ft, before entering a quartzitic sandstone perhaps belonging to the Paleozoic basement. There were no oil or gas shows. Besides, dry completions were made of wells Garlin 3 and 4 and Bastennes-Gaujacq 2.

In the Lacq field, No. 3 (a deep test) is drilling salt water impregnated Aptian sediments, at nearly 10,000 ft. The only oil zone encountered was the Lacq shallow pay. In Jurassic marly limestones beneath Aptian strata; however, very attractive oil and gas shows, then a strong gas blow-out, have just been reported. The study of this deep problem continues.

Three deep wells, Pau 1, 2, and 3, following two geological wells nearly 3000 ft deep, are exploring a large seismic structure in the Flysch trough, south of Pau and 15 miles east of the Lacq field. Important gas and oil shows have been noted in one of these wells, at about 10,000 ft, in Lower Senonian Flysch.

At this time, there are four rigs drilling deeply in the SNPA concession, one at Lacq and three on the Pau structure.

Societe de Recherches Mineralogiques du Departement des Deux-Sevres (SMRDS) Fig. 1-4

This company was created, in September, 1946, consequent to the discovery of oil seepages in Paleozoic "radiolarities," in the Mesozoic Strait of Poitou, between the Central Massif and the Hercynian Armorican Massif.

The existence of numerous anticlines in the Jurassic of the northern border of the Aquitaine basin, on the southwestern edge of the Central Massif, and of bituminous shales in the Upper Jurassic, have led this company to apply, in 1951, for an exploration permit in this area. Some geological and geophysical work have been already carried on.

Standard Francaise des Petroles (SFdeP) Fig. 1-3

In February 1951, 4,356,000 acres were leased to the "Standard Francaise des Pétroles" in the Bordeaux area, in the northern part of the Aquitaine basin. Geological information is scarce in this part of the basin, because of a thick mantle of alluvium and Miocene sediments. Two Cretaceous domes, at Villagrains and Landiras, seem to reveal the existence of an anticlinal ridge stretching WNW-ESE, 19 miles south of Bordeaux, and 37 miles north of Roquefort-Créon-Cézan-Lavardens Cretaceous ridge, in SNPA territory. Geophysical exploration (two gravity meters) is in progress.

LANGUEDOC BASIN

Societe Nationale des Petroles du Languedoc Mediterraneen—(SNPLM) Fig. 1-5

Researches anterior to 1950. At the end of 1949, 21 wells had been drilled by SNPLM; among them only 5 were over 6000 ft. There were also many geological test holes and the exploitation wells of the tiny Gabian oil field. Since the beginning of exploration in 1943, 47,417 ft had been drilled. Important wells are summarized in Table 6.

Problems studied to date have been:

Table 6

Structures	Number of wells	Max. depth (feet)	Total footage	Stages reached	Results
La Vaunage	3	13,072	33,604	Lower Liassic	High pressure gas in the Callovian at 7215–7875 feet
Quissac	1	5,414	5,414	Hettangian	Dry
Durfort	4	3,042	9,453	Paleozoic	Dry
La Gardiole	1	6,546	6,546	Paleozoic	Dry
Castelnau	1	12,468	12,468	Keuper	Dry
Coulobre	4	5,906	21,327	Carboniferous	14 bbl of oil in No. 1 well from the Lower Triassic

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First, the exploration of the Triassic (especially Muschelkalk dolomite, productive in Gabian oil field) in faulted structures close to the Paleozoic basement outcropping in the Cevennes Mountains and in the Montagne Noire (St. Chinian, Coulobre); secondly, the exploration of the Jurassic and Triassic, in the large Cretaceous and Jurassic anticlinal structures of the Languedoc basin (La Vaunage, Quissac, La Gardiole). Results have been extremely disappointing. In spite of numerous asphaltic seepages at surface, the only results have been some 14 bbl of light paraffinic oil noticed at Coulobre No. 1 in the Lower Triassic (with 15 bbl production monthly) and a slight flow of gas, rich in CO^2, and under very great pressure (4200 psi) at La Vaunage 1. This occurred in marly Callovian between 7874 and 8130 ft.

Two wells, Durfort 1 and La Gardiole 1 have been drilled to the Paleozoic basement, without encountering any show of importance. Triassic was not present in these wells.

The small Gabian field, discovered in 1924, has yielded, until 1949, 187,330 bbl of oil from faulted Muschelkalk blocks, at the edge of the Paleozoic Cevennes. Now exhausted, it was abandoned December 31, 1950.

Development in 1950 and 1951. During these two years, SNPLM has operated 5 rigs, among them 2 heavy ones. At the beginning of 1950, four problems were to be solved:

Permian and Triassic exploration in the structures bordering the Cevennes basement. Results acquired up to 1950 had shown either structures very complicated at depth (St-Chinian), stratigraphic gaps in the Triassic (La Gardiole and Durfort), a lack of porosity (Coulobre), or too big a depth (Castelnau). The study of these problems, put aside in 1950 and the first half of 1951, is being resumed in the second half of 1951. The Castelnau well, currently drilling, is attempting to explore the whole Triassic sequence. Exploitation in the Gabian field has been stopped because of excessive cost.

Exploration of the large Cretaceous and Jurassic anticlines of La Vaunage type. One rig is drilling in Lussan dome at 10,000 ft, in the Bathonian, with strong gas pressures in fissured Callovian marls.

Exploration of the Cenozoic St. Jean-de-Marvejols basin, near Nimes. In this downthrown basin, a genuine graben with Oligocene filling, asphaltic limestones have attracted attention on the petroliferous possibilities of the area. Telluric prospecting permitted the location of well No. 1, which showed the presence at about 2000 ft depth of a petroliferous sandy limestone, 130 ft thick, in the Oligocene. The oil is so heavy, however, 8 to 12 API, that it cannot be produced without steam heating. Eight wells have been drilled, which have developed some reserves and given little non-paying production, presently shut-in.

Exploration of the Camargue Cenozoic basin, in the Lower Rhone Valley. This basin, separated from the Cretaceous and Jurassic outcrops of the Languedoc area by a great fault, of nearly 3000 ft throw, offered seepages connected with the fault. Gravimetric studies, as early as 1948, discovered important anomalies. In February 1950, the first well, Vistrenque No. 1, reached Lower Cretaceous at 4265 ft under Cenozoic formations, after having encountered 0.4 bbl of oil in Oligocene sandstones. Nearly 30 wells have been spudded in 1950 and 1951, generally to a shallow depth, totaling about 68,900 ft of drilling. Only 6 of them have been drilled to over 3000 ft; the deepest reaches 5610 ft. The Quaternary, Pliocene, and Miocene filling of the basin was often drilled down to Jurassic and Cretaceous formations, which made islands or shoals in the Cenozoic sea; the Oligocene was reached in only 7 wells and drilled through in two. These old islands correspond to the heavy gravimetric anomalies (Albaron) upon which 4500 to 6000 ft of light Cenozoic sediments were deposited transgressively. (See Table 7).

Porous beds are abundant in the Cenozoic sediments and the alternate sequence of transgressions and regressions has been favorable to the formation of hydrocarbons. The petroliferous

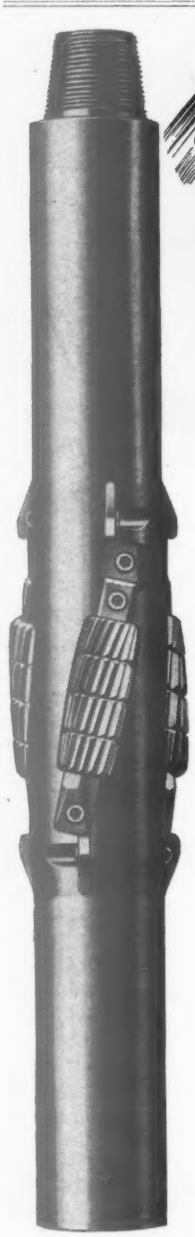

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Table 7

	Depth (feet)	Stage reached	Results
Vistrenque	4,902	Lower Cre.	0.3 bbl oil in Oligocene
Caissargues	5,063	Oligocene	Dry
Vaccares	5,611	Jurassic	Dry
Gallician	4,538	Oligocene	Bleeding core at 4529
Montcalm	4,265	Oligocene	Bleeding core at 4101
Grau du Roi	3,609	Kimmeridgian	Dry

nature of the basin is proved by oil shows encountered in the previously mentioned wells. Particularly, oil could have been accumulated in Oligocene and Aquitanian sediments; in Milhaud and Vistrenque wells, oil-impregnated beds having been encountered; drilling activity is continuing in this area.

RIVER SAONE, JURA, BRESSE, SAVOIE, AND PROVENCE BASINS

Seepages have led to geological and geophysical work in these various basins by the "Regie Autonome des Petroles" (RAP), the company which operates St. Marcet gas field. These basins are of minor dimensions and have a thinner sedimentary section than the other previously studied basins; they seem less promising, although some hope is maintained.

River Saone, Jura and Bresse basins. (Fig. 1-8) In 1947 RAP applied for a lease over 1,739,000 acres in Jura and Bresse basins. Detailed geological surveys have been carried on, especially on Treffort and Revermont anticlines where locations have been studied for core drilling. Moreover, beginning in 1938, the Government "Bureau de Recherches Geologiques et Geophysiques" has undertaken mining prospecting for rock and potash salts. This occasionally has encountered interesting hydrocarbons shows. Out of 10 shallow wells, the deepest having reached 4137 ft, 7 encountered oil and gas shows in Lettenkohle and Upper Muschelkalk dolomites. Out of these 7 wells, two are yielding a little gas production for local uses. The Revigny well, 2952 ft deep, has a potential production of 271,000 cu ft per day in Lettenkohle dolomite and it supplies domestic gas for Lons-le-Saunier. The Perrigny well has been tested for 596,000 cu ft per day potential production in Muschelkalk, at a depth of 1033 ft.

These oil and gas shows in the different stages of the Triassic formation in the Jura and Bresse areas are associated with the locally petroliferous features of the Triassic all over western Europe (Northern Germany, Pechelbronn oil field in Alsace, Gabian oil field in Languedoc basin . . .). Unfortunately, in spite of the wide geographical distribution of these seepages, no important accumulation of oil has been encountered up to now.

A rig is drilling geological test wells on Revermont and Treffort structures. Telluric and seismic surveys are progressing.

Provence basin. (Fig. 1-6) In 1947 RAP applied for leases over 1,195,480 acres in the Provence basin. Geological surveys have shown that reservoir rocks are not common in this basin, and that they are of little thickness and very deep.

Savoie basin. (Fig. 1-7) In 1947 RAP applied for leases over 308,750 acres in the Savois basin. Hydrocarbon seepages attracted attention to this area. Some of these seepages are located in the Oligocene molassic sediments, others in Upper Jurassic. Sediments do not appear very thick and reservoirs seem to be limited in volume. Geological and seismic surveys are progressing.

PECHELBRONN BASIN
Rhine Valley

The old Pechelbronn oil field was, before 1939, the only real oil field in continental France. Its production varied from 400,000 to 500,000 bbl yearly from 108,680 acres of lease land, exploited since 1735.

Oil is encountered in lenses of Oligocene sands between 600 and 3000 ft, filling the downthrown graben of the Rhine valley between old massifs of the Hercynian belt. Many faults divide this basin into numerous independent blocks. Oil is initially produced by drilling and pumping, and the lenses are then exhausted by seeping in mine galleries. At the end of 1949, 4600 wells had been completed, 691 being productive; cumulative production reached 19,811,000 bbl of 32 API oil.

With the development of petroleum exploration in France, it appeared ne-

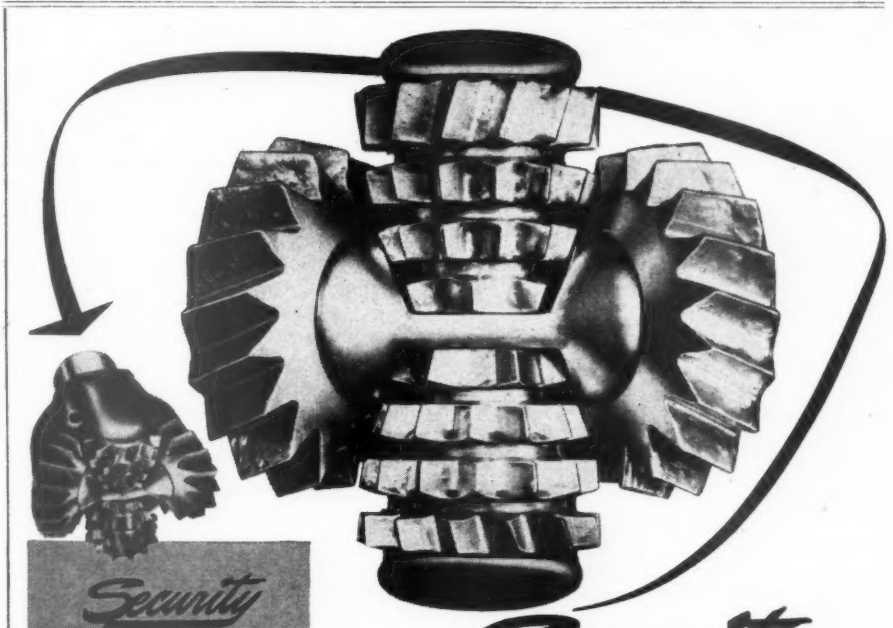
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Table 8. Production in Pechelbronn Oil Field.

	1948	1949	1950
Producing wells — Artificial lift	668	691	724
Producing wells — Flowing	0	3	12
Producing wells — Total	668	691	736
Oil production	350,000	461,000	445,000
Cumulative	19,349,000	19,810,000	20,255,000
Wells drilled — Dry	27	31	33
Wells drilled — Productive	13	26	42
Wells drilled — Total	40	57	75
Footage drilled	97,600	131,600	160,000

Table 9

	Wells completed				No. of rigs	Footage drilled	Oil production (bbl)					Gasoline production St. Marcet gas field bbl	Gas production St. Marcet MMCF
	Oil	Gas	Dry	Total			St. Marcet	Lacq	Languedoc	Pechelbronn	Total		
1948.....	14	1	48	63	47	234,850	10,800	0	0	350,000	360,000	100,000	6,144
1949.....	30	3	54	87	43	281,720	3,800	0	0	461,000	464,000	158,000	8,050
1950.....	49	0	62	111	40	348,600	1,100	444,871	4,150	445,000	878,850	200,600	8,651
1951.....	56	0	76	132	32	454,200	375	1,617,503	0	413,692	2,031,570	235,043	10,626

cessary to step beyond the narrow limits of Upper Eocene and Oligocene prospecting in the little Pechelbronn zone to take up the study, on one hand, of the deeper horizons down to the basement (Jurassic, Triassic, Permian); and on the other hand, that of the whole filling of the Rhine graben to the widest limits of the Alsace Plain. On July 21, 1949, at Soultz-sous-Foret village, flowing production of 6000 bbl in two days, was encountered in Muschelkalk dolomite at a depth of 2822 ft; the production of this well, encouraged search with a new viewpoint on the old Pechelbronn lease, and the creation of a new company, "Syndicat d'Etudes et de Recherches de Petrole en Alsace" (SERPA) on April 20, 1948, and of two new leases in the Alsace valley.

Pechelbronn SAEM Fig. 1-9

At the end of 1949, 691 wells were pumping and 3 flowing; cumulative production is 19,811,000 bbl; yearly production was 350,000 bbl in 1948 and 460,000 bbl in 1949, consequent to Soultz discovery on July 21. (See Table 8).

Well No. 4515 (located in order to continue Lettenkohle exploitation, which had proved productive in Kutzenhausen horst) on that day was drilling in Upper Keuper and crossed a fault that caused the disappearance of the major part of the Lettenkohle. Top of Muschelkalk was reached at 2156 ft and oil was found in Middle Muschelkalk. In two blowouts, during nearly 35 hours, more than 6000 bbl of oil were produced. Production, initially 500 bbl per day, showed a steady increase of salt water and finally, the well was abandoned. This discovery brought forth intense drilling activity at Soultz. Kutzenhausen, and on the other Triassic faulted structures: Sommerbaechel, Hoelschloch, Pechelbronn (24 wells with 7 rigs). Eight wells were productive (among them 7 at Soultz) and 16 wet. Soultz appears to be a gently arched anticline divided into blocks by faults. Production is obtained in Lettenkohle formation, and in the Bundsandstein oil shows have been also noted. Unfortunately, the oil is not clean and wells turn rapidly to salt water. A well in Soultz anticline has been drilled to basement which is formed by weathered granite immediately overlain by Bundsandstein.

This whole campaign, partially backed financially by the governmental organization "Bureau de Recherches de Petrole," did not lead to as many important results as expected in 1949. Oil accumulation is small and production changes rapidly to salt water.

Syndicat D'Etudes et de Recherches Petrolieres en Alsace (SERPA) Fig. 1-10

These recent drilling operations have shown the presence of oil, not only in the irregular, small-sized, and faulted Cenozoic sandy lenses, but also in the Mesozoic sediments, especially the Triassic ones, in which the existence of oil had been considered, up to now, as merely casual. Both petroliferous phenomena are probably different and superimposed. In contrast with the Cenozoic formations, the Mesozoic ones were originally continuous over large areas. Consequently, their flooding by water, from the eastern and western outcrops of the Rhine graben is very probable, at least marginally. Hence, it appears desirable to prospect, far from the outcrops, structures where oil could have been preserved in Mesozoic beds—the extreme lensing of Cenozoic sediments making their prospecting by drilling difficult and uneconomic.

Surface studies being impossible in Alsace Valley because of a thick mantle of alluvium, seismic methods have been used. Work was first begun by the Germans during Second World War by gravity, magnetics, then seismic refraction. The seismic survey gave good results. Areas corresponding to anomalies of excess gravity will be studied by seismic reflection surveys between Pechelbronn and the Rhine river in Lower Alsace.

Farther south, in Erstein region, 13 miles south of Strasbourg and in Middle Alsace, telluric and gravity anomalies detailed by seismic study have been explored by core drilling (St. Pierre and Uttenheim structures). The first deep test, St. Pierre No. 1, was spudded on December 1, 1950.

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France

Still farther south, in the intensely mined potash basin of the region of Mulhouse, accurately known Cenozoic tectonics present an anticline becoming diapiric southward, but the tectonic features in the Muschelkalk remain unknown.

PARIS BASIN

Bibliographic and field studies have begun in the wide Paris basin. Filled by Cenozoic and Mesozoic sediments and bordered by Paleozoic Massifs of the Hercynian belt, it spreads over nearly 45,400,000 acres, that is to say, a little less than a third the area of all France.

The thickness of sediments ranges up to 6000 ft; only Jurassic and Cretaceous sediments seem to be potentially associated with the formation of hydrocarbons. All Mesozoic seas up to the big Cenomanian transgression were limited northward by Artois axis. This anticlinal axis, elongated NW-SE, is the northernmost of a series of gentle ridges, uplifted at the end of Oligocene as a consequence of Alpine orogenesis. The most important one is Bray anticline, near Dieppe. In 1924-1927, the Ferrieres-en-Bray wildcat yielded the following sequence:

Jurassic	0-3700 ft
Permo-Triassic	3700-3773 ft
Basement (mica-schists)	3773 ft

Hydrocarbon seepages are of minor importance and comprise bituminous shales at various horizons, and traces of asphalt in the Carboniferous; on the contrary, in the English basin on the other side of the Channel, genuine hydrocarbon seepages are to be found in Jurassic and Lower Cretaceous (Weald) and have given rise to exploration drilling since 1937.

In the Paris basin, stratigraphic wedges, ridges, and unconformities, may be sought. During 1951, the careful study of this broad problem has been undertaken by means of geophysics and field geology.

Conclusions

The results of petroleum exploration in France, during the years 1950-1951, have been extremely promising and have been the reward of many years of studies that had remained, up to 1949, unsuccessful, if we except the discovery of St. Marcet gas field in 1939. The development of Lacq oil field, which has yielded from December 1949 up to January 1, 1952, about 2,062,300 bbl of paraffinic oil of mixed base type, 21.5 API, from 14 producing wells, is the most outstanding event in the French oil prospecting. Production in St. Marcet gas field is steadily increasing: During 1950, 8651 million cu ft gas and 200,600 bbl condensate. French oil activities and results, in 1948, 1949, 1950 and 1951 are summarized in Table 9. These results have been obtained with 40 rigs, 12 having a drilling capacity of over 8000 ft. * * *

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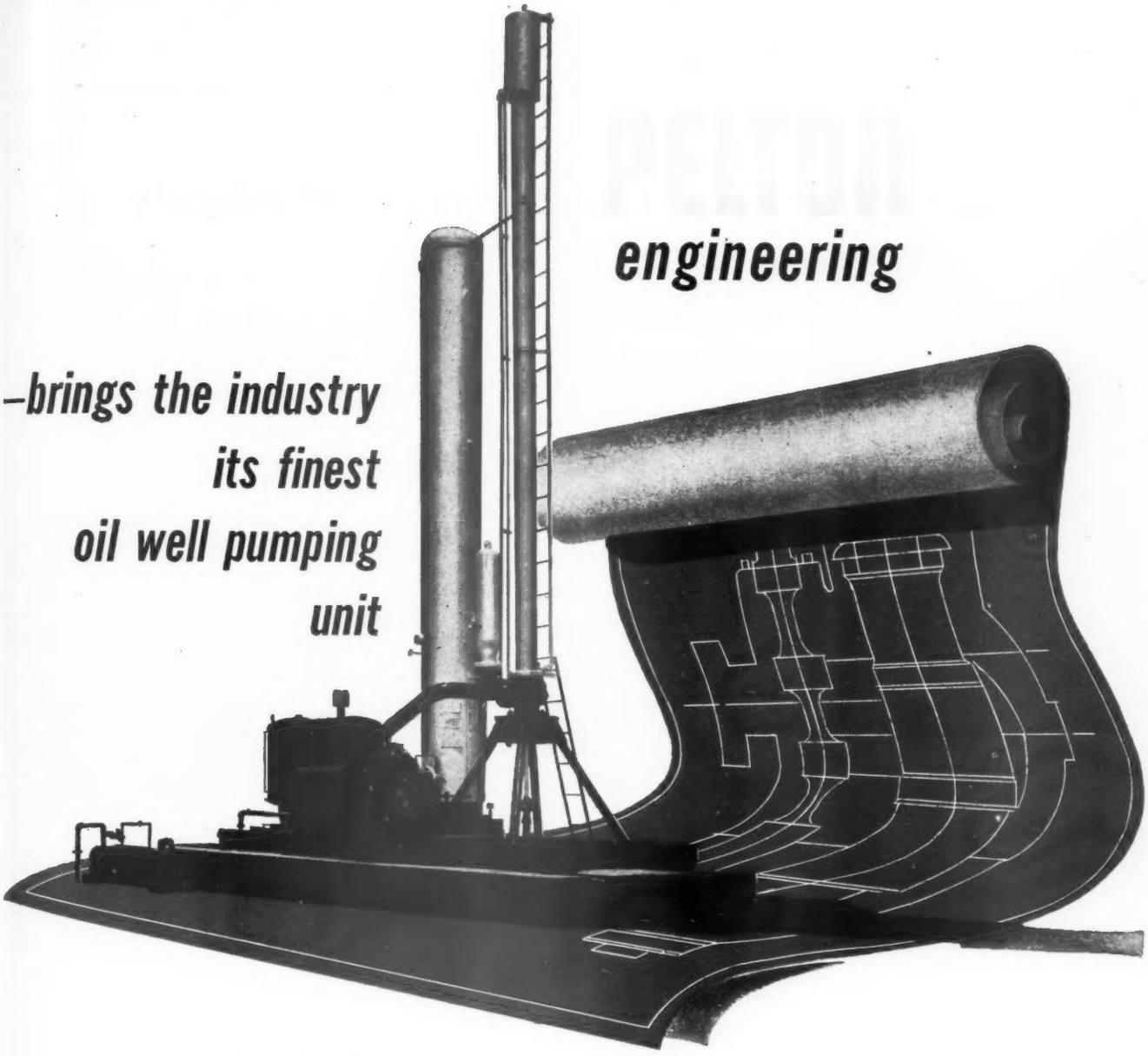

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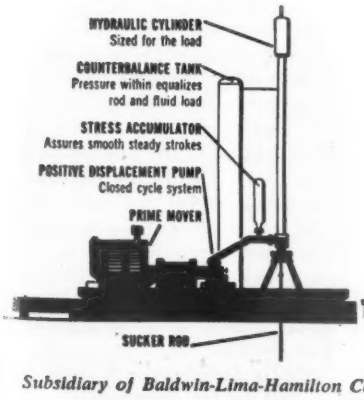

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Drilling and Completion Methods

Some of the methods used by the 110 oil and gas operators who have drilled 1100 wells in the Trend

JOHN L. COX*

THROUGHOUT this large Spraberry Trend a variety of drilling and completion practices have been utilized by the various operators. Even after 1100 wells have been completed, a wide range of opinion exists on how to complete the wells. Some operators are now completing their wells in a way they wouldn't have thought of doing six months ago. Approximately 110 different operators now have production in the Trend. Generally speaking, drilling in the area is good and drilling time proves this point. One contractor was reported to have set oil string at approximately 7000 ft in 21 days after spudding. Wells on the average are being completed in approximately 35 days when only the upper Spraberry is drilled.

Drilling Practice and Pipe Programs

Surface pipe is set at various depths from 120-350 ft in order to assure proper protection of shallow water sands. Drilling below the surface pipe is being conducted in two ways. One method is to drill through the salt section and set an intermediate string in the top of the Greyburg (approximately 3800 ft) and then drill on to the Spraberry with the salt section cased off. The other method is to drill below the surface pipe to the Spraberry and set oil string without the aid of an intermediate string. The first method was most commonly used during the initial development; however, at this time the tendency is to drill these wells without the intermediate pipe.

Some contractors have made it a practice to use only a very limited number of drill collars, fast rotation of the rotary table, and use as much water as is available in making hole. Some of these contractors use as little as three drill collars and run the rotary table at speeds as high as 125 rpm. Other contractors use from 12 to 18 collars and cut the rotary speed to 50 or 60 rpm. In general, it takes an average of 12 bits to drill the intermediate hole with an 11 and 12¼ in. bit being most popular. Usually 15 to 20 bits are necessary to make the 7¾ or 8¾ in. hole below the salt string. When drilling for a long string 30 bits have been used on the average in drilling an 8¾ in. hole. It requires approximately 30 days of rig time to drill and set pipe.

Due to the scarcity of steel, operators are very conscious of how much tonnage is being put into these wells. The best drilling practice would certainly include an intermediate string with the use of a liner. Very little mud is needed when this type of program is used and the average mud cost per well is $500 to $1500. Only a natural salt water mud is used to set the salt string. Fresh water can be used below the salt string and frequently the oil string or liner may be set without addition of any mud materials. It is sometimes necessary, however, to use fibrous material and gel mixtures on a small scale when lost circulation trouble is encountered.

Where operators have run an intermediate string less than 3 per cent attempted to circulate the cement. The use of liners has been very popular in connection with the intermediate string. Liner hangers are used to hang the pipe and the practice has been to cement from the bottom and then squeeze the top of the liner below a retainer.

Mud programs have sometimes been very expensive when drilling without using an intermediate string. The scarcity of steel is responsible for this type of casing program, which in a few instances has run the mud cost up to $20,000 per well; however, the average cost per well is $1500 to $8000. Mud control is no particular problem to a depth of 4000 ft, as a natural salt water mud is used. Many of the operators "mud up" at this depth by thoroughly cleaning the pits and rebuilding the mud volume by adding fresh water, salt water clays, oil, and material for lost circulation. Use of this type oil-emulsion is continued until pipe is set.

The intangible cost for drilling a well to the top of the Spraberry is approximately $48,000 to $55,000. This cost estimate is very general and could certainly be much higher, depending on trouble that is sometimes experienced.

Below is a tabulation showing casing programs and other pertinent data:

Casing Program—Spraberry

Intermediate and liner			Oil String	
Intermediate pipe	7⅝	9⅝ in.	7	5½ in.
Liner	5½	7 in		
Tonnage*	75½	109½	86½	54
Average mud cost	$750	$750	$2500	$2500
% of wells now being completed	22	3	46	29

*Excludes tubing.

As indicated by the tabulation, approximately 75 per cent of all wells now being completed are drilled without the use of the intermediate string, compared with the first 250 wells completed in the Spraberry of which 60 per cent were completed using intermediate pipe and liners.

Completion Programs

During the initial development of the Spraberry, operators were very careful not to get water, cement, mud, or any other material near the pay. These operators were setting pipe from 10 to 75 ft above the upper Spraberry. In some instances plastic plugs were placed in the bottom of the hole before running pipe in an effort to reduce the possibility of down hole channeling of cement. The pay was then drilled using Spraberry oil either by conventional circulation or by reverse circulation. Penetration in the pay was approximately 225 ft. The formation was then shot by using one of the many types of special oil well explosives. Considerable time was then needed to "clean out" preparatory to placing the well on production. Approximately 18 to 25 days of rig time were needed for this type of completion.

At the time the Hydrafrac process was proved to be successful in stimulating production (December 1950) most of

*Texas Crude Company, Midland, Texas.

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the operators changed to this method of completion. This proved to save money in completing the wells as rig time was reduced to a total of 3 to 7 days after pipe was set. Penetration into the pay varied from 15 to 250 ft. Fracturing volumes were increased from 750 gal on the first job to 15,000 gal on recent completions. By the use of packers some operators are selectively fracturing the pay; others are fracturing the entire open hole below the pipe in one stage. Very little difference in well capacities is noted by the different fracturing methods. Even after one year of production history from individual wells, the best completion practice is not yet known. Most operators who were penetrating only the upper 50-100 ft of formation are now confident that all the section should be penetrated for the best completion. A close study of wells with respect to penetration indicates that wells with larger penetration have a tendency to maintain the current producing rate for a longer period of time.

The cost to complete wells in this manner range from $7500 to $20,000 depending on the amount of fracture gel used. At the present time a large number of operators are experiencing a rapid decline of production in the Spraberry and are now completing wells from both the upper and lower zones (approximately 7000-8000 ft section). These operators are doing exactly what operators in the past would not think of doing, such as: Drilling the entire Spraberry section (upper and lower) set pipe through the pay, using mud as drilling fluid, perforate, and then fracture for completion. Initial results indicate this might be the best type of completion. This type of completion will certainly take in all the formation and will prevent drilling deeper at a later date if only the upper section was drilled. A very large number of operators have now standardized on drilling this 1000-ft section, using a Spraberry oil-emulsion mud; setting pipe-cementing to get approximately 1500-2000 ft fill-up (very little trouble has been experienced in obtaining the desired fill-up at the initial cement job); perforating opposite both or either zone, and fracturing with the use of packers. It is reasonable to assume this latest type of completion is best from an economical standpoint, as the lower section can be drilled during the regular drilling operations for approximately $10,000 of additional cost, whereas at a later date it would take $20,000 to $50,000 for deepening.

Other new types of completions are now being experimented with, such as drain-hole completions, drilling the pay directionally at various angles, large volumes of fracture-gel, increasing the sand content to 3 lb per gal (compared with ½ lb per gal on initial treatments). Other new types of completions will no doubt be attempted in an effort to drill these wells as economically as possible and still obtain maximum ultimate recoveries.

* * *

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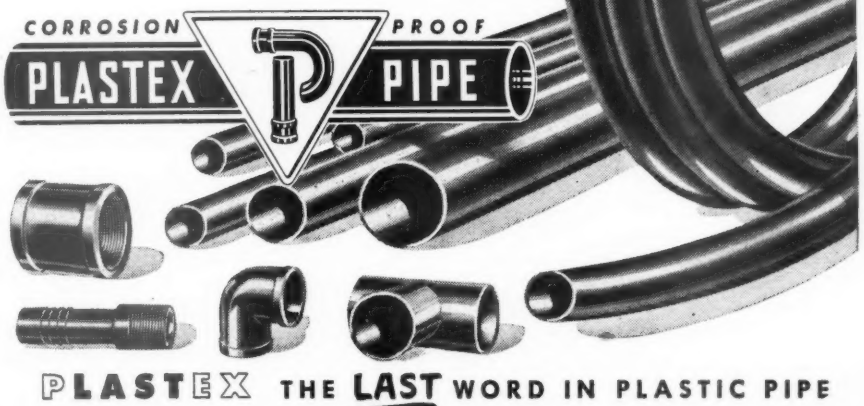

PLASTEX THE LAST WORD IN PLASTIC PIPE

Oil Reserves Menaced by Mass Salvaging

Selling equipment from producing wells in present hot market •may mean loss by both primary and secondary recovery methods

F. R. COZZENS

BACK in the 1940's, when agricultural rationing caused the used machinery market to skyrocket, a story went the rounds concerning a farmer who sold his tractor and combine in the midst of harvest and allowed the bulk of his crop to rot in the fields. During the present shortage of tubular goods and irregular allocations to the industry, not a few oil producers who chuckled at the farmer's false sense of values, are following basically the same procedure by salvaging and selling equipment from wells that are still above their economic limits in production. In low-bracket production areas, where abandonments are now being carried out on an acreage scale, many participants have already lost their remaining harvest of primary oil, and have unintentionally closed the gate against a potential second or third crop of oil.

In the light of research knowledge now shaping up in field practice, the economic value of stripper wells on an acreage basis is unpredictable. From a monetary viewpoint, the owner of a group of partially depleted wells faces the inevitable production decline while being confronted by a hot salvage market that is nearing an unstable peak. He is led to believe that his usable pipe is essential and vital to the development of more productive areas, and within those areas, the said pipe can be sold for perhaps twice its original cost, there seems little or no excuse for prolonging life in his aged wells.

From a conservative angle, however, no existing well in good mechanical condition and still capable of producing oil should be sacrificed in behalf of an exploratory venture. Each existing well represents a portion of working capital, upon which, one barrel of daily production, over and above operating expenses, will pay a substantial rate of interest. Such tied-up capital is available for a quick turn-over should any emergency arise, and in the majority of low-bracket districts the investment is solvent because, unless the area has been operated far more effectively than the average, anywhere from 40 to 65 per cent of the original oil still remains in the formation. This provides a potential reserve that in no area can be ignored, because its productivity and marginal outlines have already been established. Today's producer, in common with his pioneer predecessor, must still operate against odds, but at no other period of the industry's history have the odds for an ultimate recovery of oil been more favorable than at present. A continuous, 30-year behavior study of our three common driving mediums, (air, gas, and water), and the various reactions underground resulting therefrom, is successfully bringing through the experimental stages, a number of far more potent and versatile oil-retrieving agents, predominant among which are carbon dioxide, chemical wetting fluids, gases, carbonated liquids, and high-temperature build-ups within the reservoir. Each of these mediums, along with any others that may be developed later, require inlets for their application to the formation. Assuming all previous inlets over a given acreage have been closed through mass abandonments, an entirely new topographic picture is presented and its profile must be etched by a drilling rig because, to reclaim any probable production, operations must commence again at the surface. As all previous well equipment has been sold and removed, replacements must now be made from new allocated goods at prevailing prices. In a practical sense, an abandonment that was salvaged for $2000 worth of pipe, will cost under the present economic environment $10,000 to redrill and equip, provided the said equipment can be obtained and installed within a specified time. As a dozen or more wells over a given acreage are necessary for any decisive oil-recovery test, it is highly improbable that the prospective producer can afford to spend $120,000 and take the additional risks to regain his project. No aid is likely to be forthcoming from the area that absorbed the original equipment and the odds are ten to one that the producer, land-owner, and the industry at large loses a proved oil reserve that could have been reclaimed by means of a few old wells, left cased and intact at strategic points.

In low-bracket production territory, which now includes more than 70 per cent of our stripper oil fields, a supervised system, relative to the salvaging and plugging of wells, is urgent and necessary. Badly depleted, and treacherous wells must be eliminated as individuals and not used as excuses for group salvaging. In this respect, state laws and mining regulations should be encouraged and complied with, but not waited for. The producer, with a salvage job in mind should use discretion in the selection of pipe-pulling crews, and see to it that neighboring producers do likewise, because a single plugging laxity may seriously damage or ruin a thousand or more cubic feet of oil-productive formation. Many crew members ignore, or do not understand the techniques involved in the proper closure of a reservoir, and habitually leave pieces of pipe, sucker rods, or other metal obstacles protruding into an annulus above the oil-pay zones, thus prohibiting the effective seating of a plug. Only in rare cases are walls of the hole inspected after casing is removed, and seldom is the position of the pay-sand top verified by any measuring device before a plug is dropped. Other plugging inconsistencies that commonly accompany mass abandonments are: (1) Use of rocks, wood, cinders, and other bulky media in filling the hole; (2) release of water into the hole to destroy evidence of gas, and (3) bridging an annulus after casing is removed, to expedite a closure. These, and kindred practices, can be curbed only when the lease owner or producer assumes the role of local inspector, and sees to it that oil interests, current and potential, are benefited and protected by each salvaging job.

Before a pipe-pulling crew replaces the pumper on any lease, the producer should consider his investment in the light of knowledge already gleaned from the reservoir. A very essential part of such knowledge should be an authentic laboratory analysis, relative to the remaining oil content as attested by core samples taken from various locations on the project. No so-called "depleted" formation can be condemned upon an acreage basis when the remaining oil content is shown to be 35 per cent or higher. The owner of a property rating above this percentage should follow

EXCLUSIVE

the normal production decline among the aged, stripper-wells very closely, and weed out for salvaging only those wells that are likely to prove detrimental to his interests. These include: Leakers, freaks, blow-outs, near-dusters, wells mechanically unsafe due to badly-corroded or collapsed pipe, and other wells in which radical miscalculations have occurred in fracturing or perforating. As each remaining well on the project reaches its economic limits in production, it should be taken off the pumps and processed into a dormant receiving center for possible future use. This protective measure can be instituted at nominal cost, without the aid of any special equipment, and there is no interference with lease routine. A processed hole retains its original pipe that can be salvaged at any desired time, and a workable avenue to the partially-depleted reservoir is left open for the application of any practical oil-recovery method.

The initial objective in well processing, as it applies to a partially-depleted or low bracket field, is to conserve waning primary production while leaving a sufficient number of inlets open for future secondary developments within the reservoir. Basically, the principle is to seal, temporarily, an area of reservoir against foreign interference, and to protect the pipe against rust and corrosion by an air-tight closure at the casing-head. After tubing and rods have been removed from a spent well where no upper annulus leakage exists, the processing plan is put into action by swabbing the inner string of casing for the removal of scales and residue. Steel-line measurements are taken to verify depth and location of the lowest reducing point, and after making certain that the base is clear of impediments, a drillable, or composition plug of correct diameter and design, is seated in the top of the producing zone, or within the lowest section of pipe above gun perforations. The steel line is again used to verify the seating position that should close off any open contact with the reservoir. Plugs are generally backed up or anchored by 5 to 10 linear feet of quick-setting plastic compound that is introduced by hose, or through a string of small-diameter line-pipe. After the plastic material has attained its initial set, usually requiring 10 to 12 hours, the interior (inside walls) of the casing is sprayed with a commercial bactericide, then heavily-coated (also by spray-gun) with corrosion-resistant paint, or other protective preparations, of which there is a wide selection of commercial brands. The inner string of casing is then closed at the surface by an air-tight casing head. In wells containing more than one string of casing, the protective compound or preparation can often be introduced through the space between the strings, thus allowing the outer casing and drive-pipe to be removed for salvage. The process is completed by clearing away the pump foundation, flow-lines, etc., from around the site, and if desired, the top section of casing can be taken out and replaced with a nipple provided with an air-tight closure at the top, thus leaving no unsightly pipe to protrude above the surface.

Aside from the cost of temporary drillable plugs, which is not prohibitive, the expense of thus protecting an inlet to the reservoir is generally less than the cost of treating an equal footage of casing on the surface, and under average field conditions, pipe underground deteriorates less rapidly than surface pipe exposed to atmospheric elements. Treated wells, which are always subject to inspection, generally remain in good mechanical condition for years and may be reopened at any time within that period by drilling out the plugs, or by eliminating the closures with acids or other suitable chemicals. Reopened formation bores can be reshot or otherwise treated for reservoir developments, and the well can be used as a producer or induction point as occasion demands. At the lease owner's discretion, processing can be carried out on scattered wells, or utilized as group protection for all the spent wells on a property. Quite often, two or more neighboring or adjoining producers can cooperate in processing wells at strategic locations over several properties, thus providing potential service for a considerable acreage of reservoir.

When processing wells that produce from two or more formations, it is generally advisable to bridge the cased annulus, above and below each productive horizon with drillable materials before final closure is made at the surface. Wells in shallow sands (1000 ft or less) are often processed by the very simple procedure of filling the bore through the producing formation with crude oil, and closing the casing at the top. The oil-column may extend up the annulus to any point desired, thus affording additional protection to the pipe. The casing-heads of many shallow wells are not equipped with clamps or gaskets, and to provide an effective annulus closure, a bridge is set across the annulus, 20 to 50 ft below the surface, the space between bridge and surface being filled with aqua-gel, or similar protective compounds. In wells where tubing is set on packers capable of withstanding normal reservoir pressures, the processing is often accomplished by plugging the mouth of the tubing, then filling the annulus space between tubing and casing with crude oil, aqua-gel, or similar protective fluids. Casing, especially an inner string, must not be pulled from around tubing. Unless tubing or casing is seated within, or very near the top of an oil-bearing sand, the customary formation plugs should be used in all wells, regardless of depth, and closures made at the annulus top, because the fundamental objectives in processing are: (1) Reservoir closure; (2) pipe and annulus protection from reservoir to surface.

As processed wells take up but very little surface space, and as the ground in close proximity of the casing tops

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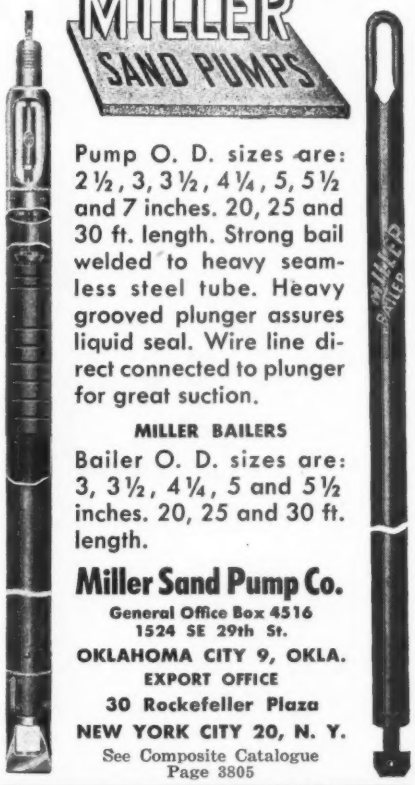

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can be cropped or grazed, farmers and land-owners as a rule, raise no objection to their retention in either field or woodland. Roads to individual wells in the dormant stage are not required; no connecting lines are necessary, and special lease concessions are therefore, rarely demanded. It is always advisable to acquaint land-owners with the purpose of well-processing, however, and to co-operate in the revision of any existing lease clauses that are detrimental to the practice. Processing clauses, whether incorporated into an old or new lease often prevent hold-ups and misunderstandings when farms change ownership.

Surveys conducted over cross-sections of the six pioneer oil producing states, clearly indicate that well-processing practices backed up by practical conservation efforts, are making favorable progress. But opportune time is running low. For each depleted well saved and processed, 8 to 10 others are being salvaged and abandoned. In many districts, low bracket leases are being junked in groups, with a bonus paid for quick salvaging. Surveys also reveal that the mass salvaging of wells, and resultant potential losses, is being carried out most extensively by smaller, independent producers who, ironically enough, control through leases, more than 65 per cent of our low bracket fields, and can least afford the sacrifice. Admittedly, hundreds of low bracket lease owners in the past have been deprived of water floods and kindred oil-recovery measures because of the extensive necessary installations and exorbitant costs. Therefore, until recently, there was ample evidence to support the excuse that when primary production reached its economic limits, the small producer was through as an oil man, and might as well salvage his leases while prices were firm. The newer oil recovery practices now in development, however, are revising this picture, inasmuch as many of the techniques are especially adapted to small properties, and even to individual wells. Obviously, the areas that have been salvaged prematurely and entirely abandoned will be passed up in initial tests, and preference given to those areas where strategic avenues to the reservoir are still preserved and remain open. The producer who, thoughtfully, has retained such wells, even on a limited scale, then becomes a major factor in bringing an economic revival to his district. In a practical sense, he regains his rightful share of existing oil, and his tied-up capital is still covered by the monetary salvage value of his pipe when ultimate abandonment of the wells eventually becomes necessary. Consequently, if future oil recovery methods are to be utilized in field practice, the rank and file of low bracket producers require an immediate awakening to the fact that wide scale junking and salvaging of oil properties constitute waste of invested money and materials. Waste is unhealthy in any division of the industry, but is particularly serious when it restricts or prohibits the recovery of oil from a proved reserve. * * *

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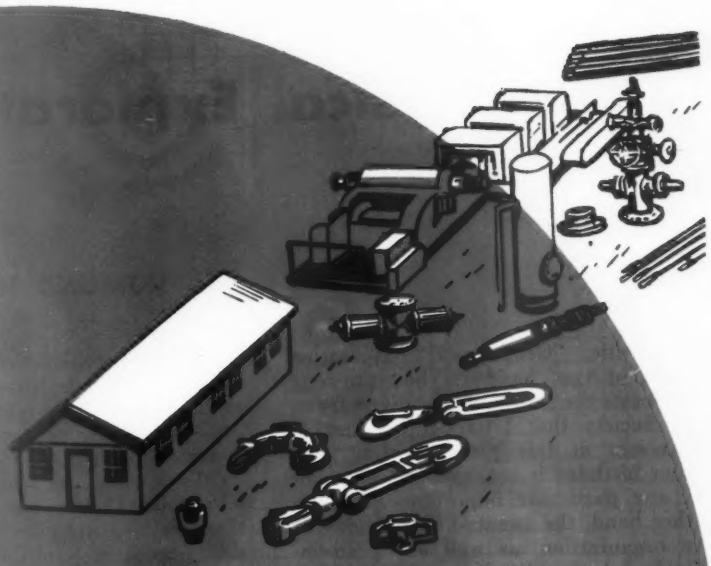

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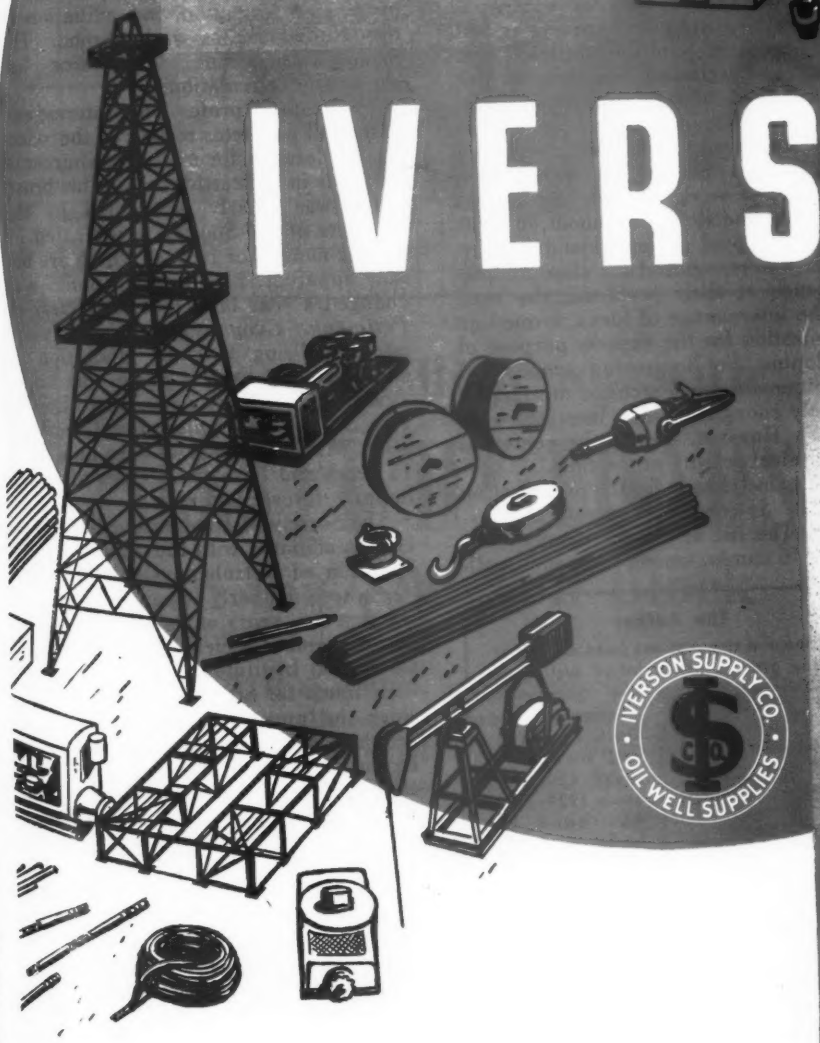

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SEG Presidential Address

Geophysical Exploration Comes of Age†

SIGMUND HAMMER

My title, "Geophysical Exploration Comes of Age", has been chosen to commemorate the twenty-first anniversary of the Society that I have the honor to represent at this great meeting. Another birthday is not, of itself, an event of any particular importance. On the other hand, the twenty-first birthday of an organization, as well as of an individual, has traditionally been the time to stop to review the past, to take stock of the present, and to consider the prospects for the future. Following this precedent, I shall attempt (1) to review the growth of geophysical exploration, particularly in the United States but not ignoring foreign developments; (2) to point out where geophysical exploration stands today; and (3) to try to peer into the future to catch a glimpse of what may lie ahead.

In terms of the history of science and technology, geophysical prospecting is very young. It is true that important deposits of iron ore were discovered by magnetic surveys so long as a hundred years ago. But we need not stop to consider that ancient phase. The modern age of geophysical prospecting can fairly be said to have begun in 1915 when an Eotvos torsion balance survey successfully extended the deep flanks of the Egbell structure in Czechoslovakia.[1] This was apparently the first deliberate application of geophysical prospecting, in the modern sense, to oil-finding. As we all know, this is the fertile field in which the geophysical prospecting science and art has flourished and grown to its present stature of world-wide industrial importance.

It is of interest to point out that the idea of applying geophysical measurements in the search for oil could hardly have occurred much sooner because, according to DeGolyer[2], the year 1913, only two years earlier, marks the beginning of the acceptance of geology as a guide to prospecting.

All of us realize how vast is our present profession. Few realize how quickly, in how very few years, it has developed.

The history of the development of geophysical exploration is very intimately related to the history of the Society of Exploration Geophysicists. Seismic and gravity crews were brought from Germany to the Gulf Coast in the early 1920's to aid in the search for salt dome oil fields. The spectacular success of these early geophysical surveys is well documented in published articles, textbooks, and technical monographs. But, the first flush of success faltered. It became necesssary for two, heretofore almost unrelated, scientific disciplines, geology and physics, to merge their thinking, to work together for further progress. And so it came about, in 1930, that a group of geologists and geophysicists who recognized the close interdependence of their problems, the need for the interchange of ideas, formed an organization for the express purpose of developing and improving geophysical techniques in the search for oil. Appropriately enough, the first meetings were held in Houston, Texas, the center of geophysical activity at the time.

The name chosen for the organization was *The Society of Economic Geophysicists.* The list of charter members includes 46 names, among them such well-known geologists as Alexander Deussen and Donald C. Barton. Today the membership approaches 3000 in 41 states and 49 foreign countries. There are nine local sections and three student sections. Four additional sections are in process of formation and affiliation in the United States and abroad. The Society's magazine *Geophysics* has world-wide circulation.

The scope of professional interest embraces all problems related to the scientific exploration for mineral resources of all kinds in the earth's crust. This broad scope was clearly envisioned by the founders of the Society as indicated by its first name. For reasons which are not now apparent, however, the name was changed a year later to *The Society of Petroleum Geophysicists.* Five years later, realizing that the limitation in scope implied by this name was undesirable, the present name was chosen: *The Society of Exploration Geophysicists.* With this name, we have now lived 15 years and have fond hopes of living happily forever after.

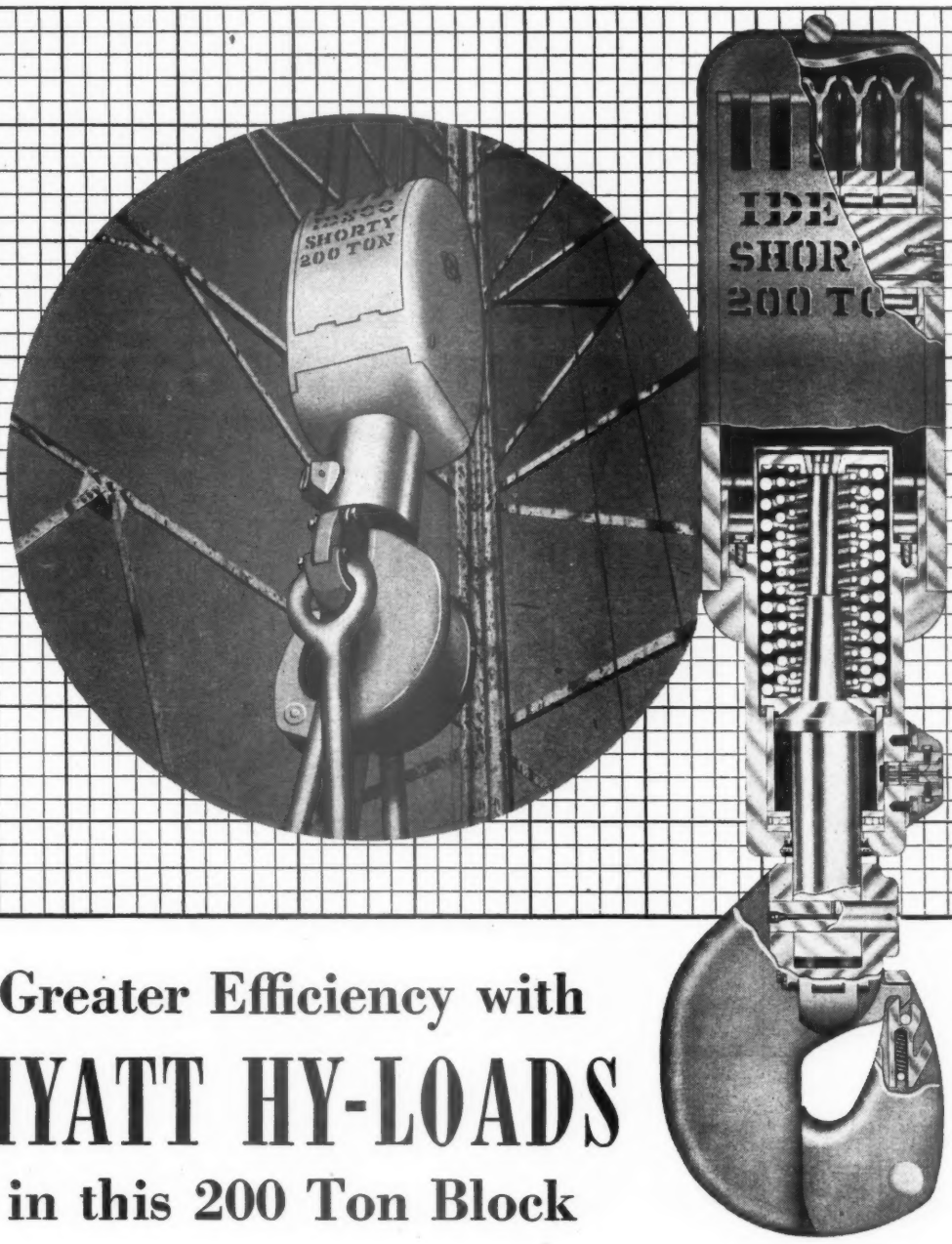
The Society of Exploration Geophysicists is affiliated with the American Association of Petroleum Geologists, under whose motherly wings it nestled in the first few years of its existence. It is also a member society of the American Geological Institute.

So much for history. Let us now consider the present economic stature of geophysical exploration. The Society of Exploration Geophysicists is professionally concerned with all geological exploration problems: Petroleum, mining, civil engineering, and so on. The applications to exploration for petroleum are well developed. Last year, official SEG records show $325,000,000 was invested in world-wide geophysical explorations by the oil industry alone. This represents a phenomenal increase over 1950 of $100,000,000, an increase of nearly 50 per cent. Additional millions were undoubtedly spent in mining explorations and for research in the improvement of present techniques and the development of new methods. The increased expenditures last year are due partly to inflationary rise in costs and partly to increased activity. When we realize the magnitude of our present operations, we must concede that we are

The Author

Sigmund Hammer has been employed in the gravity interpretation section of the geophysics division of the Gulf Research and Development Company since 1929, and has been in charge of the section since 1946. He also is a lecturer in geology at the University of Pittsburgh, where he teaches a course in geophysical prospecting. A graduate of St. Olaf College, Northfield, Minnesota, Hammer taught at the University of Minnesota, where he received his PhD., from 1924 until 1929. He has published several technical papers on the gravitational field of the earth, geophysical prospecting, and geophysical applications of the statistical theory of errors. He was 1951 president of the American Association of Petroleum Geologists and 1950 national vice president.

†Presidential address delivered at the joint annual convention of the American Association of Petroleum Geologists, The Society of Economic Paleontologists and Mineralogists, and the Society of Exploration Geophysicists, Los Angeles, California, March 25, 1952.



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Geophysical exploration activity today[3], on a world-wide scale, marks an all-time high: 791 seismic crews, an increase of more than 20 per cent over 1950; 123 gravity crews, an increase of 12 per cent over 1950. Surprisingly, the trend of geophysical activity last year was toward the United States, away from foreign areas. This probably reflects industrial concern over unstable political philosophies about mineral resources.

The mineral industries, the petroleum industry in particular, are investing great sums of money in geophysical exploration. The commercial acceptance of geophysics is justified by its success. Lahee's well-known and exceedingly useful statistical analyses[4] report the success expectancy of a wildcat well drilled in the hope of discovering a new oil field (a "new-field wildcat" in Dr. Lahee's terminology) for various bases of selecting the drilling site. Rounding out the small annual fluctuations (which are not significant for our purpose), we get averages for the last five years (1947-1951) is the United States as follows:

Basis	Success Ratio
Non-technical (random drilling)	1 in 30
Geological	1 in 10
Geophysical	1 in 6
Combined Geological and Geophysical	1 in 5

The improvement resulting from the application of the best modern exploration technique—geology and geophysics combined—is very impressive. Compared to random drilling, the saving amounts to 25 dry holes per discovery, 4 dry holes instead of a wasteful 29. When we consider that the total expenditure for the geophysical data is only about 10 per cent of the total cost of oil exploration, these statistics take on additional significance.

And still, Dr. Lahee's tables continue to show, year after year, a surprisingly large number of wildcats in the non-technical column! It is encouraging to see, however, that the number is gradually decreasing. Here, indeed, is a fertile field for our public relations committees.

Modern geophysical instruments and techniques are well developed, especially in the United States and Canada. Qualified geophysicists throughout the world concede freely that American instruments and American geophysicists are the best to be had. The technical achievements are indeed impressive. Let us consider one example. Twenty odd years ago, the establishment of a single gravity station required two full days with a large truck load of equipment, and the result that did not become available until the pendulum could be standardized at the home base several months later had a probable error of plus or minus two or three milligals. Today, only two short decades later, a modern gravimeter about the size of a two-quart Mason jar and weighing only 6 lb will establish a gravity station in about two minutes with an accuracy of plus or minus 0.03 milligal. This represents a 50-fold advantage in weight, a 100-fold gain in accuracy, and a 500-fold gain in speed. Similar examples could be cited with other geophysical instruments. Without these technological improvements, geophysical prospecting as we know it today would be entirely ineffectual and prohibitively expensive.

An asset of even greater importance is our stock of trained geophysical manpower, which has been painstakingly assembled and carefully nutured over the years. The solution of complex geological exploration problems, even with the best geological and geophysical data obtainable, depends essentially, in the final analysis, upon the interpreter's personal experience and judgment. The present and prospective shortage of technical talent in our schools and colleges presents a challenge we must meet.

Future Prospects

Let us now peer into the future. We are often reminded that our present proved petroleum reserves are only sufficient to supply the wheels of industry for about 15 years and, therefore, that we have an urgent need, in the face of rising demand, to increase the discovery effectiveness of our exploration techniques. That is a real problem that faces us right now—today. Many geophysicists and geologists, are devoting their best efforts, generously supported by

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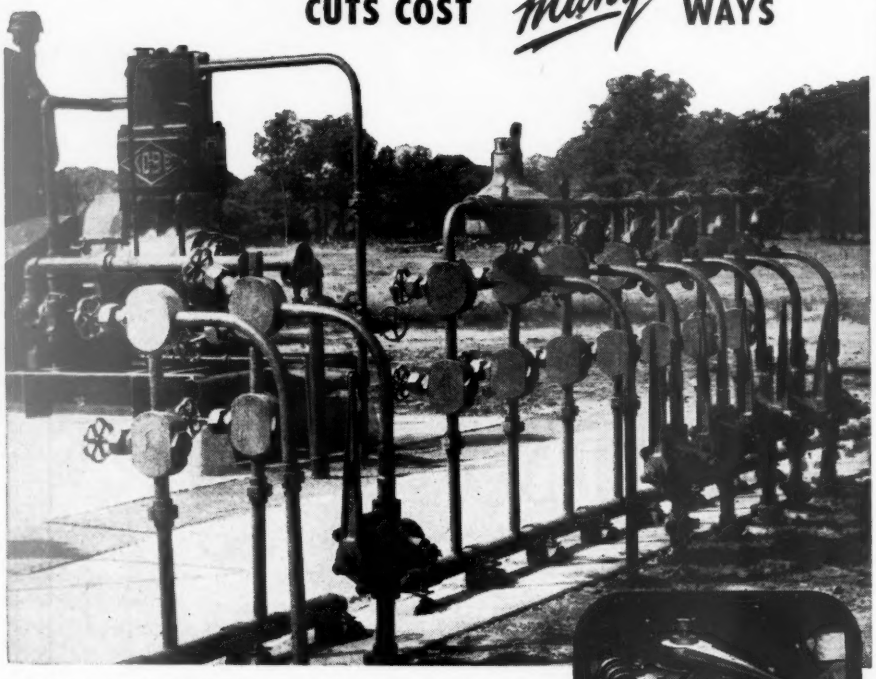

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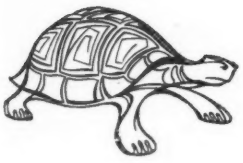

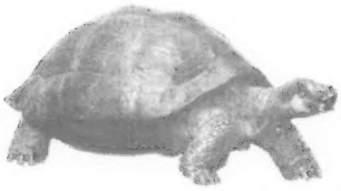

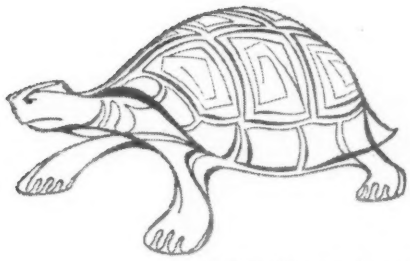

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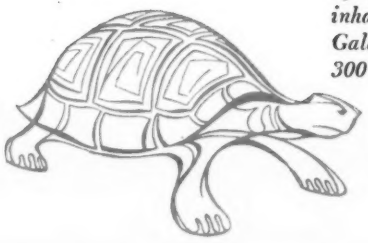

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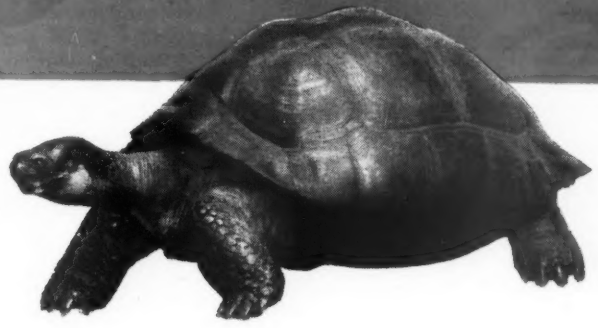

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management, toward the solution of this problem. I am quite confident that so long as any oil remains in the earth to be discovered profitably it will be found.

We are not doing too badly right now. Last year, according to published statistics, the United States produced 2,243,000,000 bbl of crude oil[5]. That is a lot of oil—an all-time record. It takes a lot of doing to discover enough new oil to supply such a demand. However, the exploration departments of the American oil industry did even better. The estimated amount of reserves in the new oil discoveries during 1951 not only replaced the amount consumed but also added 1½ billion barrels to the "proved reserves".

On the other hand, young men entering college are often deterred from choosing geophysics or petroleum geology as a career because they have heard the prophets of doom shouting about the impending shortage of oil. Unfortunately, it is the brightest young men, the men who could be expected to contribute most to the solution of the problem who give heed to these dire predictions and are misled into other fields of endeavor.

Therefore, it is worth while to take a broader view. The total amount of petroleum discovered throughout the world to date, including about 70 billion barrels consumed and 50 billion barrels in the "proved reserves", is about 120 billion barrels. Estimates of potential world petroleum resources that remain to be discovered are about 600 billion barrels[6] or five times as great.

At the present world-wide discovery rate of about 6 billion barrels of oil per year, this should keep us in the business for about 100 years.

Even this bright picture might be unduly pessimistic. It is based on the tacit assumption that oil is a one-crop proposition and that none is being formed in the earth today to provide distant future discoveries. Recent evidence suggests the attractive possibility that oil may, in fact, be forming in the vast volume of sediments being deposited today[7]. This opens possible glorious vistas for the future.

As a professional society, the commodities the Society of Exploration Geophysicists has to offer the exploration industry are instruments, techniques, and ideas. Of the three, ideas are by far the most important. Paradoxically, ideas, while rare, are the cheapest ingredient of our industrial economy. The success or failure of a wildcat well costing perhaps as much as a million dollars is often crucially dependent upon the mental inspiration of the exploration geophysicists and geologists who selected the drilling site. It is the recognized responsibility of our societies and of meetings such as this to inspire all of us to new and better ideas to improve our exploration techniques now and in the years ahead.

The president of a large oil company said recently[8]: "Science and technology are the biggest forces for progress in the oil industry today. Almost all of our present techniques and operating procedures are the results of improvements and developments made by scientists, engineers, and technologists. The conclusions of the technical men serve as a base for the decisions of management."

Surely, geophysical exploration for oil has reached maturity. Geophysical exploration for other minerals is on the way up. So long as we, geologists and geophysicists, continue to work together as we are now doing to develop new ideas to solve our problems as they arise, we as professional men can face the future with confidence.

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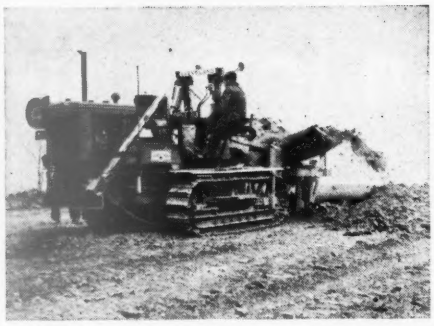

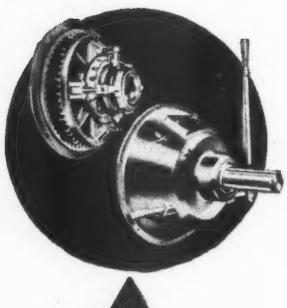

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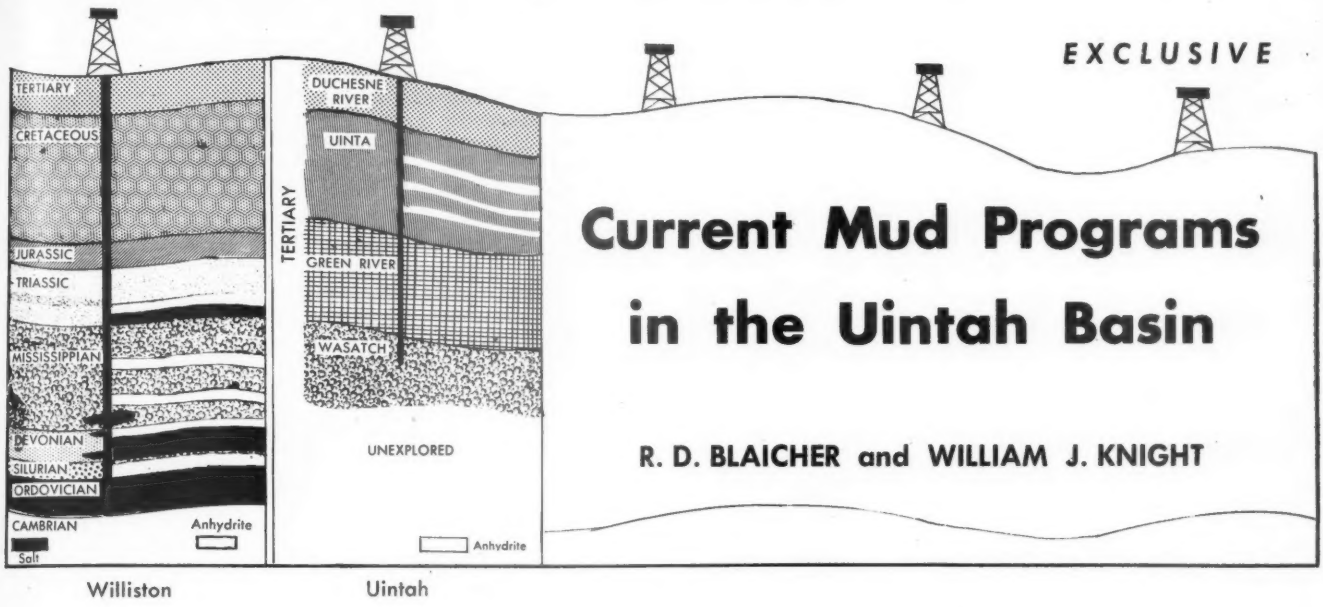

EXCLUSIVE

Current Mud Programs in the Uintah Basin

R. D. BLAICHER and WILLIAM J. KNIGHT

This is the second article of a series on mud programs in the new "Areas of Promise," which are presently being explored for oil and gas reserves.

THE Uintah Basin is the name generally applied to an area covering several million acres in northeastern Utah and northwestern Colorado. Three sides of the basin are bounded by large mountain ranges and the south by the Roan and Book Cliffs. In Colorado, along the margin of the basin, several fields have provided commercial oil and gas production from pre-Tertiary formations for many years. Less than three years ago, however, oil was discovered in commercial quantities in the thick, widely developed Tertiary formations in the Utah portion of the basin. The purpose of this discussion is to illustrate the role drilling mud has played in the discovery and development of these large Tertiary oil reserves.

In the latter part of 1946 a comprehensive exploratory program was initiated resulting in general wildcatting in northeastern Utah. The first Uintah Basin Tertiary discovery was in June, 1949. This well produces from fractures in the so-called "oil shale" of Green River Age. The crude, although of medium gravity, contains approximately 40 per cent paraffin and has a pour point of 90 F.

Formations penetrated, in the basin, consist primarily of hard, abrasive Tertiary rocks. Penetration rates are slow and the operation costly because of the hardness of these sediments. The holes drilled remain close to bit gage; therefore, the problems normally associated with hole enlargement or washouts are minimized. Drilling mud costs are mostly the result of (1) maintenance of low filter loss muds over long time intervals to protect possible producing zones throughout the Green River formation and; (2) loss of returns in fractured zones. Since the most prolific of oil wells are producing from fractured shale, any loss of mud to these fractures is of major importance. Because of this, mud weights are maintained at a delicate balance between the maximum weight, which results in loss of mud and, the minimum weight necessary for confining oil and gas to the formation.

Fig. 1 shows a typical cross section near the deepest part of the basin and the average thickness of the four principal Tertiary formations; namely the Duchesne River, Uinta, Green River, and Wasatch. With the exception of the Green River, the Tertiary sediments consist of red variegated shales with irregular sandstones and conglomerates. Anhydrite stringers are present throughout the Uinta formation. The basal part of the Green River formation is almost entirely carbonaceous shale with thin beds of dense dolomite and dolomitic siltstones.

Roosevelt Area

The discovery well in the Roosevelt area, named for the town of Roosevelt 30 miles southwest of Vernal, Utah, was completed in June, 1949. It had an initial twenty-four hour flow of over 1600 bbl of 33 gravity oil after acid treatment of a fractured zone from 9351 to 9392 ft. Since then, several additional

The Authors

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R. D. Blaicher has been a service engineer with Baroid Sales Division, National Lead Co., since graduating from the University of Tulsa in 1947. He has gathered experience working with mud and related problems throughout Texas, Kansas, and the Rocky Mountain area. In April 1950 he was transferred to Baroid's division office in Tulsa, Oklahoma, as assistant division field service engineer.

W. J. Knight

William J. Knight, a native of Oklahoma, was graduated from Oklahoma A & M College in 1947 with a degree in chemical engineering. After graduating, he joined the research and development department of Baroid in Tulsa. He was transferred to Rocky Mountain area in 1949 as a service engineer with assignments in Wyoming, Montana, and North Dakota. In 1950 Knight was transferred to his present position as Baroid's field service engineer in Vernal, Utah.

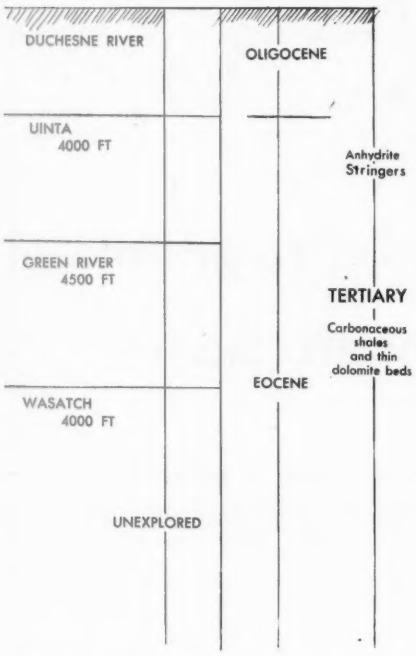

FIG. 1. Geological section—Roosevelt area. Typical cross-section near the deepest part of the Uintah Basin and the average thickess of the four principal Tertiary formations.

wells have been drilled below 9500 ft. The deepest was situated 18 miles west of the discovery well and abandoned in the Wasatch formation at 12,518 ft. In the Roosevelt area the Duchesne River formation occurs at the surface and is approximately 1500 ft thick. After setting from 500 to 800 ft of either 10¾ in. or 13⅜ in. surface pipe, water is used as the drilling fluid through the lower part of this section.

The Uinta formation is approximately 4000 ft thick and consists primarily of shales interbedded with sandstones and anhydrite stringers. Drilling the Uinta formation is not particularly difficult because most of the problems encountered can be eliminated by proper mud practices. The nature of the shales requires heavy water dilution to control the concentration or build-up of native solids in the mud. This dilution should be great enough to prevent the mud weight from exceeding 10 lb per gallon. It is good practice to add (1) sufficient bentonite to provide a colloidal concentration, giving filter losses of 10 to 12 cc API and; (2) mud thinning chemicals to give an initial gel strength of zero. Such a mud will minimize hole enlargements through the shale section thereby reducing the points where cuttings could accumulate. The reduced annular mud velocities through enlarged sections are responsible for cutting accumulations. Prevention of such enlargements overcomes the necessity for the higher mud viscosities required to counteract the effect of reduced annular mud velocities. Abrasive sand may accumulate in the mud. Serious damage to drilling equipment can result unless proper action is taken to remove the sand from the mud system. As an aid to sand removal, chemical mud treatments of caustic soda mixed with the tannin, humic, or lignitic type thinners, will produce the low initial gel strengths necessary for settling sand in the pits. A pit design causing slow bank to bank movement of the mud facilitates this settling action. Frequent jetting and cleaning of the pits then removes the settled sand from the mud system. When the anhydrite ($CaSO_4$) in the Uinta formation is drilled, the mud is chemically treated with barium carbonate to remove completely, by precipitation, the flocculating calcium and sulfate ions. This maintains or restores the original quality of the mud.

In the Roosevelt area the top of the Green River shale is usually found between 5500 and 6000 ft. Production is from the numerous permeable fractured zones which occur throughout this thick shale body. Drilling mud requirements may be based on the following considerations.

(1) It is desirable to control the unit mud weights so that small positive hydrostatic pressures are maintained to minimize mud loss to the potentially productive fractures. Quite often mud lost to the formation is the first indication of a fractured condition. Then, a production or "drill stem" test is usually made for evaluation purposes.

(2) It is desirable that any mud exposed to these fractures has low filtration properties to reduce the possibility of filtrate contamination of the oil shows.

(3) The mud should have low gelation rates to minimize the pump pressures required to break circulation. This reduces the possibility of forcing mud into the formation through the existing fractures or induced openings.

On several wells high-pH-lime-starch muds have been used successfully to drill the long Green River shale section. The low initial and final gel strength characteristics of this type mud reduces the pump pressures necessary to break circulation. Modified starch, which is preserved by the high pH of the mud, is the filter loss control agent and is added in sufficient quantities to reduce the filter loss to the desired value. Mud weight is controlled by the addition of water. Bentonite is added to give the necessary viscosity for cleaning the hole. To control formation pressure of 4500 psi at 9000 ft, mud weights in excess of 9.6 lb per gallon are required. Loss of circulation to the shale fractures is a constant problem. To combat this condition, muds are treated with the fiber, mica, and cellophane type of lost circulation materials. Typical mud properties in the Roosevelt area, before and after conversion to a high-pH-lime-starch mud, for drilling the Green River shale are shown in the following chart:

	Before	After			
Depth, feet	6046	7462	8740	9076	10026
Weight, pounds per gallon	10.4	9.6	9.6	9.8	9.6
Viscosity, Sec., API	43	37	61	65	63
Initial gel, grams, Stormer	0	0	0	0	0
10 min. gel, grams, Stormer	8	0	0	0	0
Filter loss—cc. API	12.0	1.5	2.8	2.4	2.8
Cake—32nd in.	2	1	1	1	1
pH	8.5	12.5	12.5	12.5	12.0

Red Wash Area

The discovery well in the Red Wash field, situated approximately 40 miles southeast of the Roosevelt area, was completed in January of 1951. Production is found in the basal Green River zone at about 5500 ft with the top of the Green River section at 2700 ft. Loss of circulation is a continuing problem throughout the shale body and is particularly troublesome in the upper Green River at about 3000 ft. Early in the development of this field, high-pH-lime-starch muds were used to drill the fractured shale body. As development continued production zones were defined more clearly and mud designs were modified to conform with hole conditions. A typical mud program in this area now consists of drilling with a chemically treated bentonitic mud from 3600 to 4400 ft with viscosity and filter loss requirements determined by hole performance. While drilling the basal Green River from 4400 ft to total depth of about 5500 ft, sodium carboxymethylcellulose is used for filter loss control. Typical mud properties are illustrated in the following chart:

Depth	3811	4637	4846	5538
Weight, pounds per gallon	8.8	9.15	9.1	9.2
Viscosity—Sec., API	62	54	66	65
Initial gel—grams, Stormer	0	0	2	2
10 minute gel—grams, Stormer	16	40	30	12
Filter loss, cc., API	6.0	5.2	4.6	3.5
Cake—32nd in.	2	2	2	2
pH	8.5	9.0	9.0	9.5

As exploration continues throughout the basin and holes are drilled to deeper horizons, additional problems will be encountered that can be overcome through proper design and control of drilling muds. High-pH-lime-starch muds have been the most successful for drilling the long Green River shale section. They provide the necessary stable gel strength and filter loss control over long time intervals and through wide weight and viscosity ranges. ★ ★ ★

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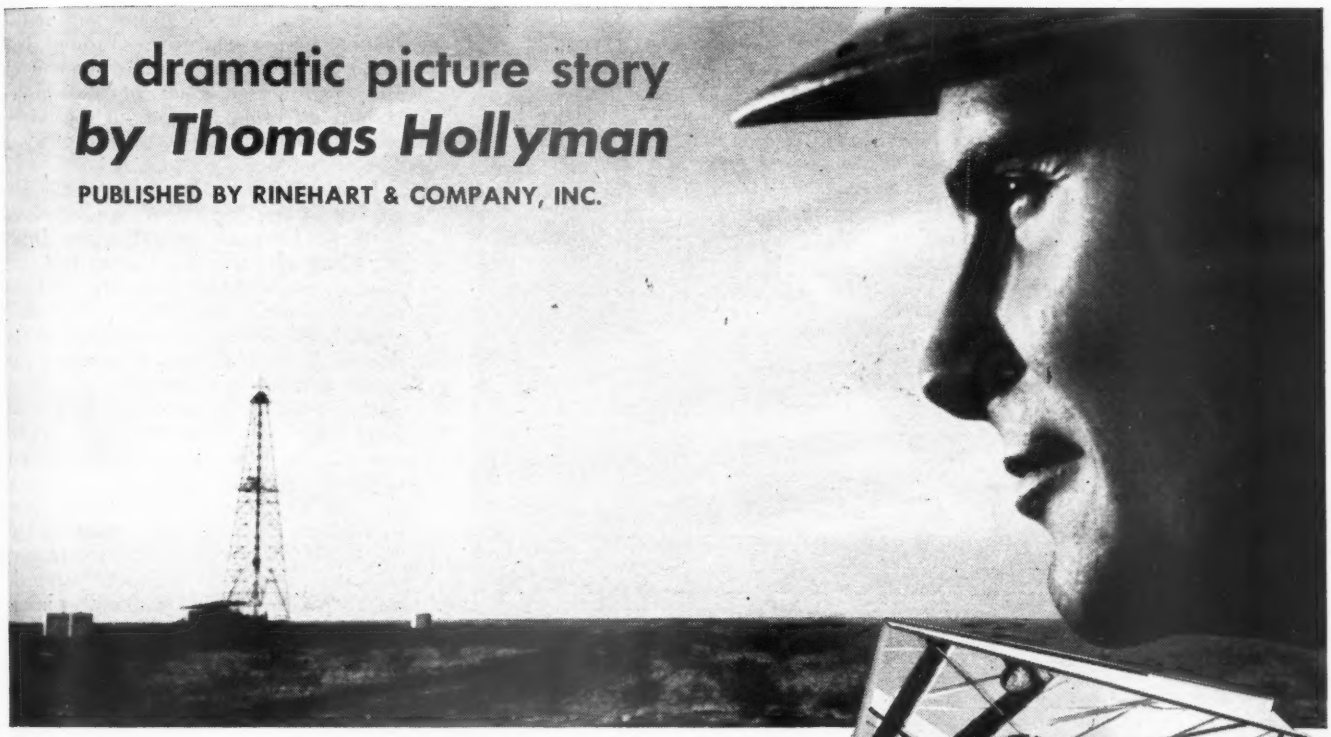

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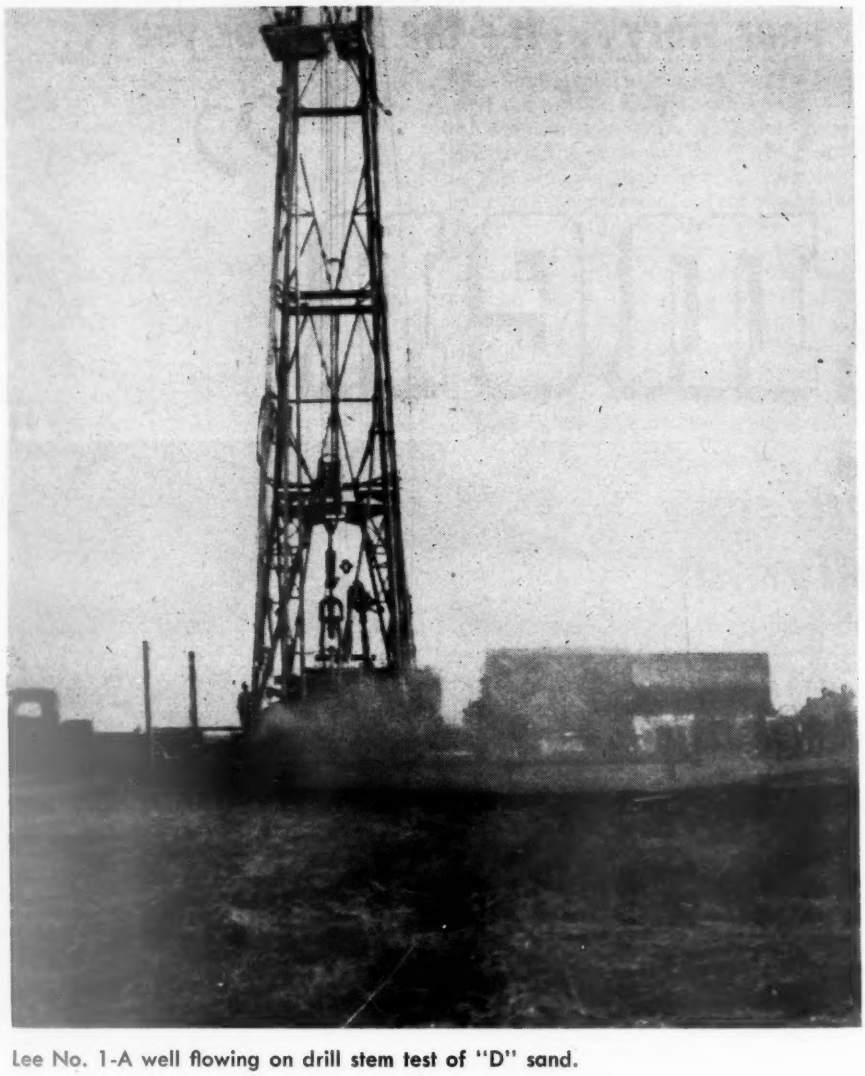


Lee No. 1-A well flowing on drill stem test of "D" sand.

THE LEE FIELD

Morgan County, Colorado

C. R. NEAL

LEE field area of Morgan County, Colorado, has been of interest to geologists for some time. The area has been mapped by several geologists, using different data as an elongated asymmetrical anticline trending roughly northwest-southeast and being approximately three miles in width and six to seven miles long. This structure has been known by various names as the Fort Morgan anticline, Round Top anticline, and perhaps others. It is situated in the east central portion of the Denver-Julesburg structural basin.

Some of the events leading to the discovery of production in the Lee field will be of interest to persons unfamiliar with the area and the writer will attempt to relate some of the more important ones. In 1949, Murphy and others drilled the No. 1 Mowry, in the C/NW SE of Sec. 6-2N-56W, to a total depth of 6001 ft. This well topped "D" sand at 5363 ft (–890), "J" sand at 5436 ft, Cloverly at 5740 ft (all formations of lower Cretaceous age), and topped the Morrison formation of Jurassic age at 5980 ft. Shows of oil and gas were reported in the "D" sand with no tests being made and the hole was plugged and abandoned. Adams Drilling Company commenced the No. 1 Lee in the C/E½ SW NE of Sec. 2-N-57W in December 1949. This well encountered "D" sand at 5445 ft (–950). The well was drilled to a total depth of 5541 ft, 16 ft in the "J" sand, and fair to good staining was encountered in the "D" sand section from 5449 to 5459 ft with minor shows logged in the top few feet of the "J" sand. Attempted drill stem tests failed, the well was plugged back in open hole and 7-in. casing set at 5449 ft to test the show in the "D" sand. At this time, J. M. Huber Corporation acquired an interest in the well and other acreage in the area. The "D" sand was tested making some sweet green crude of 39.4 gravity and a considerable amount of fresh to brackish water. Several unsuccessful attempts to shut off the water were made and the hole was plugged and abandoned.

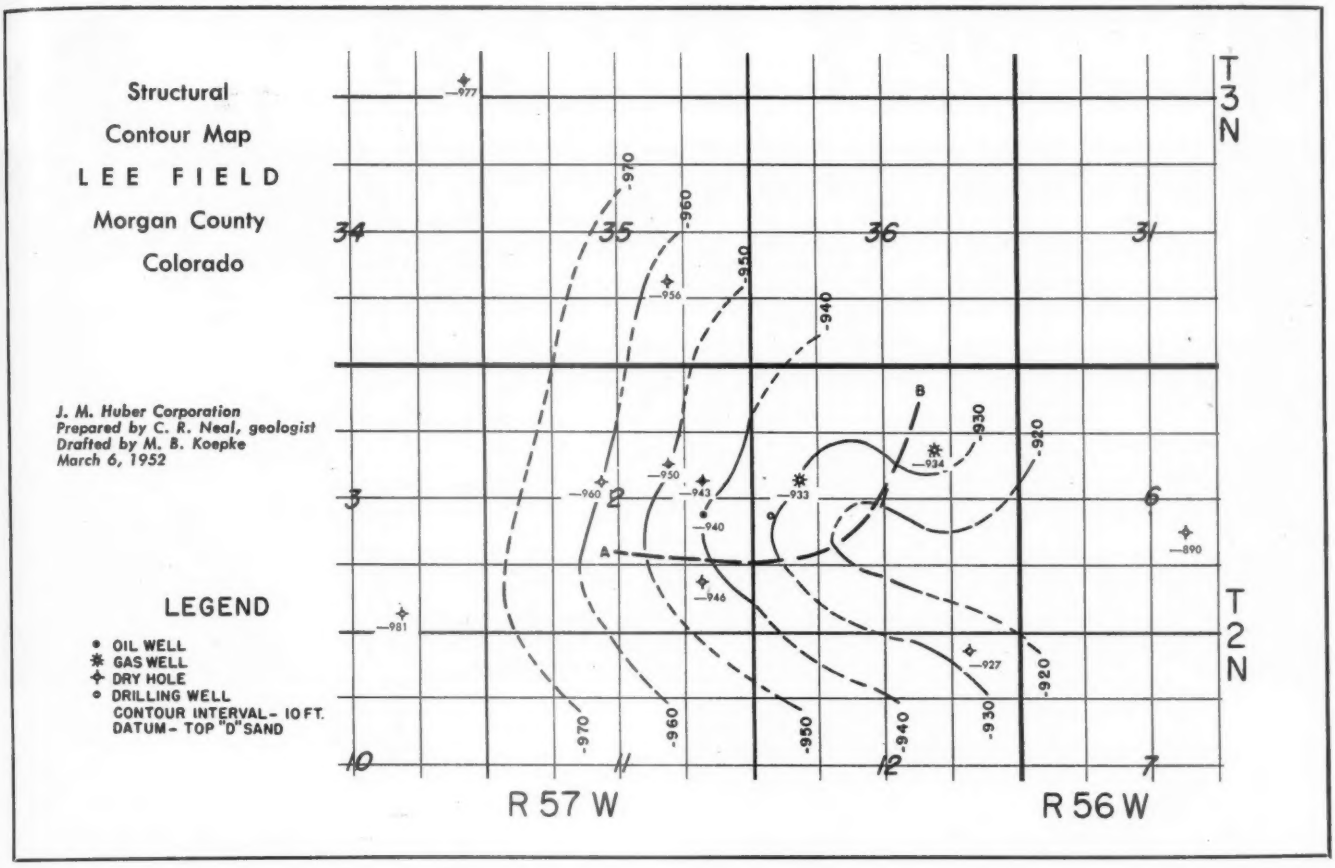
In June 1950 the No. 2 Lee in the SW SE NE of Sec. 2-2N-57W, a joint effort by Huber Corporation and Adams Drilling Company, tested oil from the "D" sand to become the discovery well for the field. This well topped "D" sand at 5438 ft (–943), drill stem test of the interval 5441-49 ft, open 35 minutes, gas to the surface in 11 minutes, estimated 25 to 50,000 cu ft, recovered 1385 ft of fluid (715 ft of oil and 670 ft of brackish water). The hole was carried to a total depth of 5478 ft where 5½-in. casing was set. The zone, 5440-52 ft, was perforated for an initial production of 140 bbl of oil per day with a small amount of water. This well produced approximately 3400 bbl of oil before being plugged and abandoned due to water and mechanical difficulties.

A discussion of some of the other wells in the field is perhaps necessary in order to advance a theory on why the Lee field is productive. Lee No. 1-A, in the NW NE SE of Sec. 2-2N-57W, was commenced in July 1950. "D" zone was topped at 5437 ft (–940) where 14 ft of broken stained sand was found. A 6-ft core of the "D" sand was analyzed

The Author

C. R. Neal has been with J. M. Huber Corporation since 1949, working primarily in the Rocky Mountain region. He was graduated from the University of Oklahoma in 1943 with a BS degree in petroleum engineering, and after three years service during World War II, joined Cities Service Oil Company. Upon completion of the junior engineer training program, he was assigned to the geological department, working three years in Kansas, prior to joining J. M. Huber Corporation.

EXCLUSIVE



giving the following averages: Permeability, 445 millidarcys; porosity, 21.2 per cent; residual saturation, 12.3 per cent; water saturation, 37.8 per cent; and a calculated connate water saturation of 30 per cent. The accompanying photograph is one of this well flowing on drill stem test of the "D" sand. This well was completed through perforations for an initial gage of 115 bbl of oil per day with no water, and has produced in excess of 14,000 bbl of crude in a 15-month production period before it became necessary to install pumping equipment. Huber Corporation Government-Smith No. 1, in the SE SW NW of Sec. 1-2N-57W, was dually completed as a gas well producing from both the "D" and "J" sands. Top of the "D" sand was logged at 5443 ft (–933) and "J" sand at 5519 ft (–1009). Initial production from the "D" sand was 7,440,000 cu ft per day and 4,936,000 cu ft per day from the "J" sand. Core analysis of the 11-ft pay section of "D" sand gave the following averages: Permeability, 224 millidarcys; porosity, 16.6 per cent; residual saturation, 0.3 per cent; water saturation, 33.4 per cent; and average calculated connate water saturation of 29 per cent. The Government-Lee No. 1, in the NE SW NE of Sec. 1-2N-57W, was completed as a non-commercial gas producer from the "J" sand. "D" sand was logged at 5449 ft (–934) and recovered water on the drill stem test. "J" sand was logged at 5526 ft (–1011), had poor porosity and permeability, and initial production from the top 14 ft of sand was 560,000 cu ft per day with a small amount of water. In the Derby Oil Company Lee No. 1, in the NW NE NE of Sec. 12-2N-57W, "D" sand was logged at 5432 ft (–927), was quartzitic and poorly developed. Huber Corporation Lee No. 2-A, in the NW SE SE of Sec. 2-2N-57W, cut a normal "D" sand section at 5449 ft (–946) and made water on drill stem test although it was only 3 ft lower structurally than the discovery well.

The Lee field appears to have both structural and stratigraphic influences. The structural contour map, as contoured on top of the "D" sand, shows the production to be located on a structural nose. The theory advanced by the author explaining the trapping of oil and gas is based primarily on the physical characteristics of the "D" sand zone and performance of some of the wells drilled in the area. The "D" sand seems to be thinning to a degree in an easterly direction as evidenced by a study of electric logs. A comparison of porosity and permeability between the Lee No. 1-A and Government-Smith No. 1 shows the Lee No. 1-A to have approximately twice the permeability and about one-fourth greater porosity than the Government-Smith No. 1. A comparison of the Lee No. 2-A and Government-Lee No. 1 shows both wells making water on tests of the "D" sand, the Lee No. 2-A being 3 ft lower structurally and Government-Lee No. 1 being 9 ft higher structurally than the discovery well. The line A-B on the structural contour map is thought to be the approximate location of an updip porosity and permeability barrier aided perhaps by thinning of sand deposition in the "D" zone to account for the trapping of oil and gas in this field.

As is readily apparent, the author has made no attempt to explain the presence of gas accumulation in the "J" sand in this field; however, it is believed that with additional information it would be possible to explain such accumulation by a similar and parallel theory such as that set forth for "D" sand production.

New Denver-Julesburg Well

Newest apparent discovery for the Denver-Julesburg Basin is S. D. Johnson's No. 1 Conockaert, wildcat in Morgan County, Colorado. The new well is north of the Lee oil and gas pool and 6 miles southwest of the Messex pool. Gas reached the surface in 7 min.

Recovery included 900 ft of oil, 90 ft of oil-cut mud, and 810 ft of water. Flowing pressure was 270 to 750 psi and shut-in pressure was 1525 psi in 15 min. The "J" sand zone was tested between 5856-65 ft.

Acknowledgment

The author wishes to thank J. M. Huber Corporation for permission to publish this article, and appreciates suggestions and criticisms offered by A. D. Turquette and J. R. Clair. * * *

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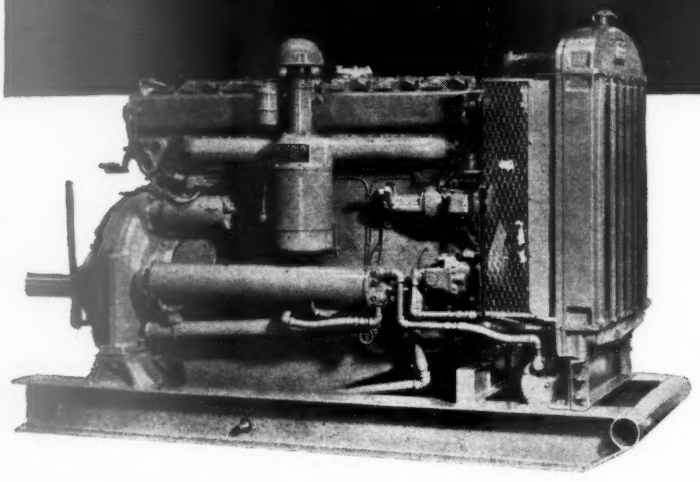

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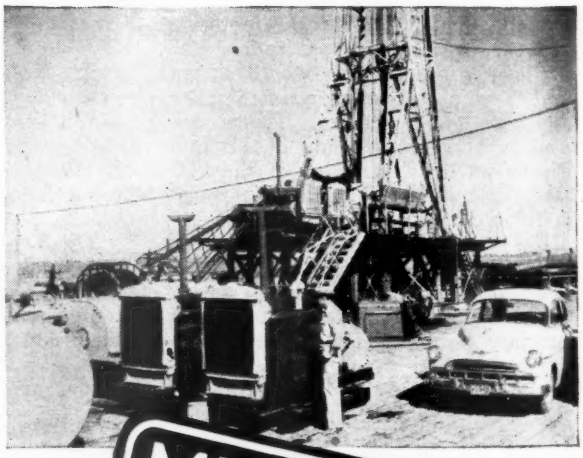

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Cost Trends in Contract Drilling

JOHN McEWEN*

Report released by Contractors Statistical Committee

The necessity of accurate cost information is urgent for the management of all business enterprises and more particularly for a business as hazardous as oilwell drilling. With costs increasing rapidly, but with no corresponding increase in revenues, it became obvious to a group of California drilling contractors in 1951 that they must promptly study their costs factually. To accomplish this the Contractors Statistical Committee was formed, consisting of approximately 30 contractors.

The committee procured the services of a consultant and staff for the accumulation of pertinent statistics. The resulting cost information has been incorporated in an interesting report now available to drilling contractors and oil operators by writing to Contractors Statistical Committee, 508 Subway Terminal Building, Los Angeles 13, California.

DRILLING costs have advanced by huge percentages since 1945, but not all contractors have developed accurate costs that are a necessary basis for the establishment of sound business policies. The result has been wide differentials in estimated costs and many contractors found themselves seriously squeezed in 1950 and 1951. As a result of the serious situation thus created, a group of California drilling contractors determined to make a careful study and analysis of conditions and costs for the benefit of the industry.

The Contractors Statistical Committee was formed of approximately 30 contractors representing approximately 120 drilling rigs. A working committee of engineers and accountants was appointed to work with E. R. (Ray) Love of A. D. Rushing Drilling Company, as consultant, and his staff, to compile pertinent statistics. Information was carefully collected and analyzed and the basic summaries are presented for the use of both contractors and operators.

Costs Increased Substantially and Rapidly

It should be noted at the outset that many of the figures are already on the low side and further increases in labor and equipment costs are imminent. Many depreciation rates are based on 1945-47 equipment costs and the owner will find his depreciation reserves inadequate when he goes out to buy modern replacement rigs at current prices.

Average costs were submitted by contractors in a uniform manner and the results of this study are shown in Exhibit "A".

Variation in rates for "Day Work" is often a controversial subject. This is, in part, explained by differences in age of the drilling outfits on which the average drilling costs are based. This is clearly shown in "Cost Spread" tabulation shown in Exhibit "B".

Cost Breakdown

The average over-all percentages of costs for the four class breakdowns and the six representative sizes of drilling rigs is as follows:

1. Labor	48.23%	of total rig operating cost
2. Maintenance and repairs	24.06%	of total rig operating cost
3. Rental and depreciation	14.70%	of total rig operating cost
4. Overhead	13.01%	of total rig operating cost

Equipment Replacement

The individual contractor knows his average present-day cash out-of-pocket operating cost. What he often does not know with reasonable accuracy is the cost in terms of present-day replacement value of each operating day's use of drilling equipment, which he purchased on a much lower-priced market than now exists.

The average daily operating costs as tabulated are indicative of the actual daily operating costs for the contractor who is competitively bidding for drilling jobs today. A fairly large percentage (possibly 60 to 70 per cent) of the drilling equipment in state-wide use now is nearing the end of its most efficient use-life. The question is—"How may drilling contractors purchase new modern outfits?" There appears to be no simple and quick answer under today's tax and economic picture. The question requires careful and complex analysis by each contractor for his specific situation.

If a rig is fully depreciated, the owner is subject to a double penalty:

1. A rig that has been fully depreciated is old enough to have high maintenance costs and excessive down time that is non-revenue time.
2. If a normal depreciation charge is not offset by excessive maintenance or down time costs, any favorable differential goes to profit and is subject to a minimum of 28¾ per cent to more than 52 per cent for Federal corporation income taxes.

The contractor, if he plans a sound continuing business and service to the petroleum producing industry, is obliged to make an analysis of the over-all long-time profit possibilities of operating older equipment versus newer and more efficient equipment. Obviously the decision to purchase new equipment must be made before the old rig is unacceptable to the customers. Contractors, as business people, must not overlook that depreciation charges (return of invested capital over minimum working life of equipment) are deductible just as are operating expenses for purposes of corporation income tax calculations. Normally, industry conditions will be the one largest single factor influencing the judgment of the contractor in determining when to replace old equipment.

Equipment Costs Have Risen Substantially

Figures published in a trade magazine by a Mid-Continent contractor in March, 1951, indicated that drilling equipment had advanced 74.73 per cent, drill pipe 45.3 per cent, and drill collars 56.23 per cent in price since 1945. Using these percentage figures with the September, 1951, cost of two representative complete drilling outfits, the comparison is as follows:

	Sept. 1951 cost		1945 cost
6500 ft rig	$257,819.16		$147,552.88
7000 ft 4½ drill pipe	31,940.30		21,982.11
Subs and drill collars	14,320.82		9,166.50
		Increase	
	$304,080.28	70.16%	$178,701.49
8500 ft rig	$405,260.43		$231,935.23
10,000 ft 4½—12,000 ft 3½	88,217.00		60,713.70
Subs and drill collars	14,320.82		9,166.50
		Increase	
	$507,798.25	68.25%	$301,815.43

*Consulting engineer, Contractors Statistical Committee.

The figures shown in the column "September, 1951, Cost" are based upon machinery and drill pipe supplier's direct quotations. The rigs are priced complete in all detail, including modern blowout valves, controls, control heads, drilling masts of latest design, torque converters with diesel engine power, 2 power pumps of adequate size — one separately powered, all manifolding for pumps; water, fuel, and air lines; electrical generating plants, pipe racks, and all appurtenances.

Daily Operating Costs

In order to arrive at an "Average Daily Operating Cost" for new 6500 ft and 8500 ft rigs at "September, 1951, Cost" it was necessary to set up some scale by which the use life of completely new rigs could be measured in order to set up a figure that could be used to represent the actual money value each "Operating Day" takes out of the drilling equipment.

To set up the "Use Life" a number of committee members, the equipment suppliers, and equipment engineers were consulted.

Using the "Use Life" operating days as agreed upon by the working committee, the value taken out of the two sizes of new drilling rigs for each operating day of eight hours or more may be set up thus:

Average	6500 ft rig	8500 ft rig
Value used each operating day:		
Machinery and equipment	$196.23	$297.56
Drill pipe and accessories	87.75	98.87
Total each operating day	$283.98	$396.43

Substituting these average figures in the place of the average daily rental and depreciation figures shown in Exhibit "A", for rigs of comparable size, the average daily operating cost increase is; assuming only that other average costs are not increased, and a reduction of 20 per cent is achieved for the maintenance and repairs on new rigs; as tabulated:

	1 Labor	2 Maint. and repairs	3 Rent and depr.	4 Overhead	Total	Increase per cent
6500 ft Exhibit "A"	358.86	151.95	98.88	101.75	711.44	
Sept. 1951	358.86	121.55	283.98	101.75	866.14	21.74%
8500 ft Exhibit "A"	358.86	197.09	123.48	101.75	781.18	
Sept. 1951	358.86	141.40	396.53	101.75	998.54	27.82%

At "Day Rates", for these two examples, the cost of operating new rigs versus older rigs is substantially higher —actually $154.70 per day or $6.45 per hour more in the case of the 6500 ft outfit; and $217.36 per day or $9.06 per hour more for the 8500 ft outfit.

Conclusion

As is common with all businesses at this time, drilling contractors have not only the general problems common to most industries, but their own special problems as well. The natural hazards of drilling contractors are always serious and the situation is all the more critical when they must base their business judgment upon the complexity of property taxes, income taxes, increasing operating costs, higher costs for replacement rigs, and the lag that has occurred between increased costs and offsetting increased revenue.

The petroleum industry depends heavily upon the drilling contracting industry and this study is intended to assist the contractors in their management planning so that through sound economic policies the drilling industry shall always be in position to meet satisfactorily its obligations to the petroleum producing industry.

The Contractors Statistical Committee recommends a careful study of this cost analysis by all drilling contractors. Sound business policies for each contractor can only be based upon the development of sound cost information by each contractor for his specific condition.

* * *

EXHIBIT "A"

CONTRACTORS' AVERAGE DAILY RIG OPERATING COST

	Size crew	Average daily operating cost 1 Labor	2 Maint. and repairs	3 Rental and depr.	4 Over-head	Daily average cost	High low	No. rigs
3,500 ft	4	307.27	106.04	49.58	76.11	539.00	588.18	5
Per cent of total		57.00	19.67	9.21	14.12		459.95	
4,500 ft	4	307.27	133.39	69.14	76.11	585.91	638.00	18
Per cent of total		52.44	22.77	11.80	12.99		529.92	
6,500 ft	5+	358.86	151.95	98.88	101.75	711.44	769.00	26
Per cent of total		50.44	21.36	13.90	14.30		634.01	
8,500 ft	5+	358.86	197.09	123.48	101.75	781.18	845.58	22
Per cent of total		45.94	25.23	15.81	13.02		716.06	
10,000 ft	5+	358.86	216.40	141.51	101.75	818.52	906.80	14
Per cent of total		43.84	26.44	17.29	12.43		750.00	
12,000 ft	5+	358.86	260.89	182.27	101.75	903.77	1,010.00	8
Per cent of total		39.71	28.87	20.17	11.25		828.26	

NOTE: The average costs do *not* include the following items:

1. Travel or other special allowances to crews due to location.
2. Bits.
3. Mud or additives.
4. Fuels.
5. Blowout preventer rentals.
6. Fishing tool rental.
7. Casing tool rental.
8. Moving in and out.
9. Rearrangement of equipment to fit location.

EXHIBIT "B"

AVERAGE DAILY DRILLING COST SPREAD BY RIG DEPTH CLASSIFICATION

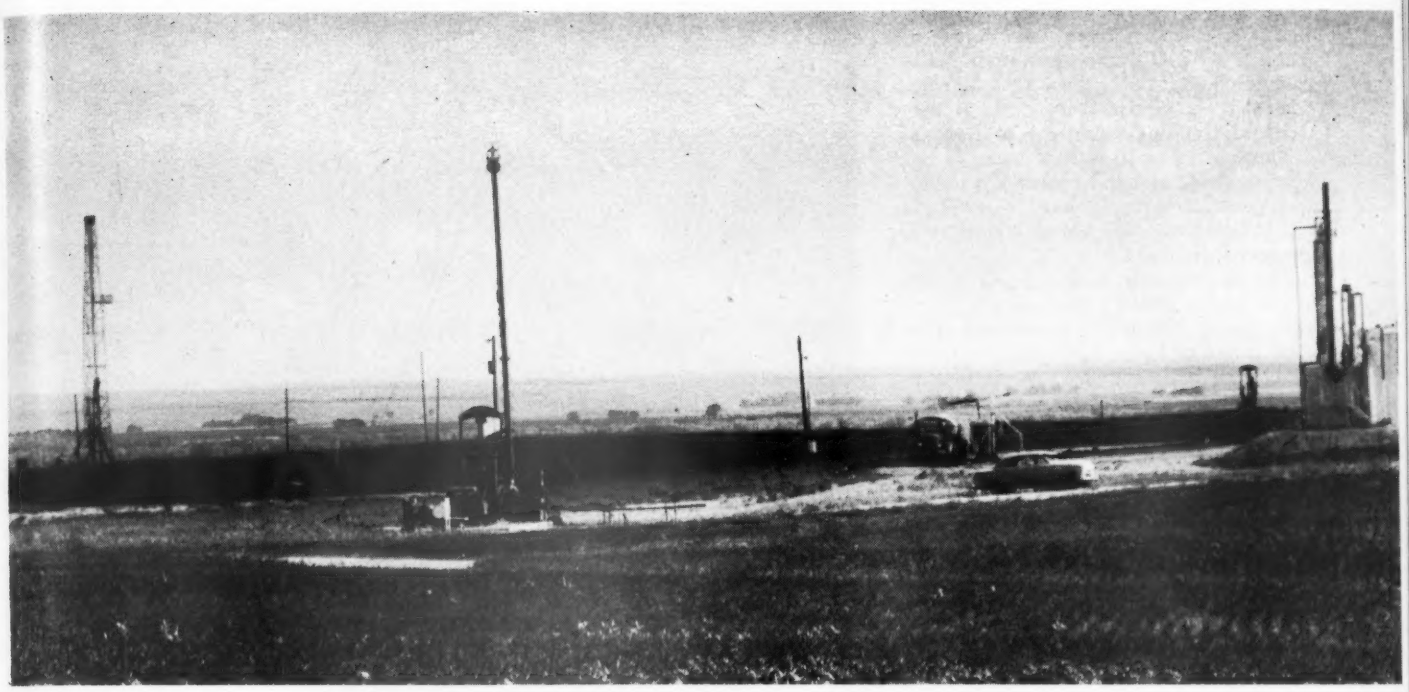
	Number of contractors	Average high	Average low	Average difference per day	Maximum difference per day	Maximum difference per hour
3,500 ft	5	588.18	497.98	90.20	128.23	5.34
4,500 ft	10	620.21	574.50	49.71	108.08	4.50
6,500 ft	10	730.13	669.67	60.46	134.99	5.62
8,500 ft	10	785.53	766.50	19.03	129.52	5.40
10,000 ft	7	854.96	802.41	52.55	156.80	6.53
12,000 ft	5	927.76	864.13	63.63	181.98	7.58

Drilling and Exploration Buys Texla Gas Common Stock

Drilling and Exploration Company, Inc., Abilene, Texas, has acquired all of the properties of Texla Gas Corporation, Dallas. By the trade, Texla Gas stockholders will receive 18,032 shares of Drilling and Exploration common stock.

Drilling and Exploration will assume all obligations of Texla Gas, which is to be liquidated.

Drilling and Exploration will take over management of the Texla properties, which constitute approximately 40 per cent of the Lisbon and Northeast Lisbon gas field in Claibourne and Lincoln Parishes, Louisiana. J. E. Brantley, Abilene, is president of Drilling and Exploration Company, and Lewis T. Lohman, Dallas, was head of Texla Gas.



Oil from the Carter wells is hauled by tank truck to Merino, where it is shipped by rail to Denver.

MERINO FIELD, COLORADO

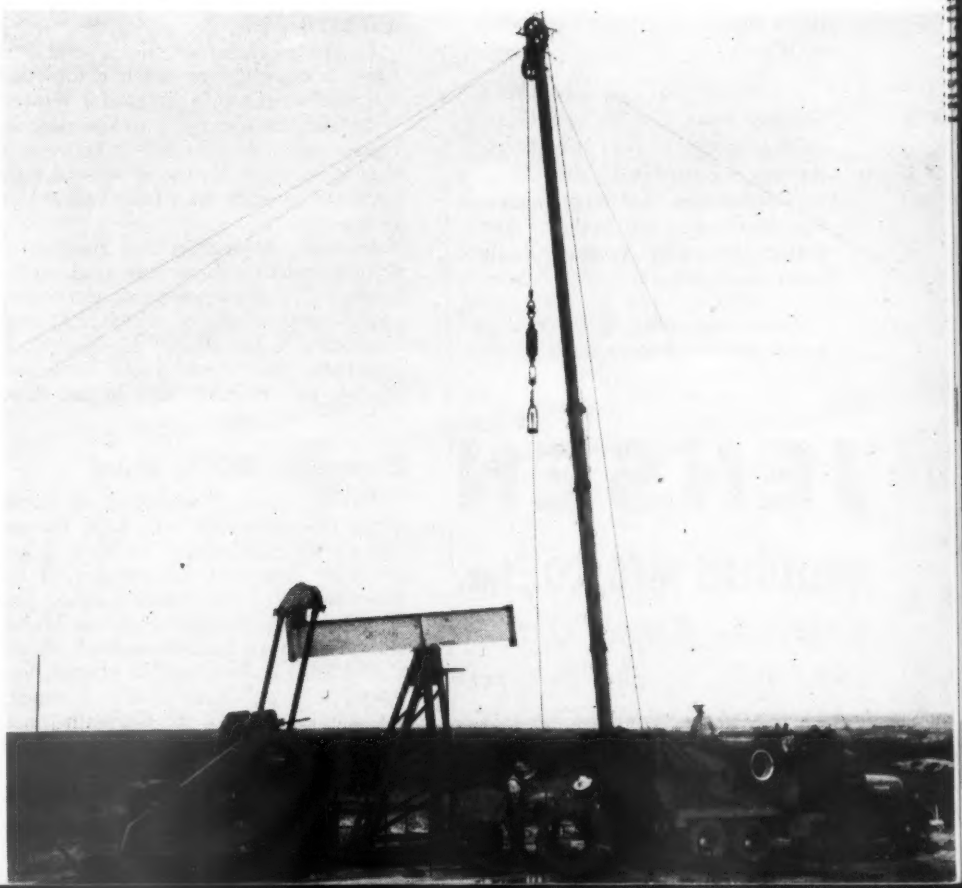
One of the small but numerous oil fields that have sprung up in the Denver-Julesburg area

EXCLUSIVE

CARTER Oil Company's wells in the Merino pool, Logan County, Colorado, are the result of extensive exploration in the Denver-Julesburg Basin which began as early as mid-1950, and rocked Colorado to second place in the total wildcat locations selected in 1951. A total of 169 wildcat locations were selected and 62 wells are currently drilling in the Basin's 38,000,000 acres, of which 29 are wildcats and 33 are pool wells. Eleven new oil fields were discovered in the Basin last year, and rival seismograph crews continue to search the broad flat land for hidden structures that might contain oil.

Carter completed its first well in the Merino pool, 40 miles east of Fort Morgan, Colorado, in November of 1950. Now Carter has a production of 242 bbl a day from this pool.

Carter's No. 1 Ruth Nicholson well is typical of the Merino area. It pumped 153 bbl of 42.5 deg gravity oil in 24 hr



Setting up pumping equipment, Merino field.

from the Graneros formation below 5042 ft when it was completed in August, 1951. Oil from the Carter wells is hauled by tank truck to Merino, where it is shipped by rail to the Oriental Refining Company at Denver.

There are now 16 wells drilling in the Merino field, and the reported production cumulative to January 1, 1952, is 472,457 bbl, 425,020 bbl of which were produced in 1951.

The eastern side of the Basin is one of the busier drilling areas in the U. S. with about 100 active operations. The wide range of lease ownerships, as well as the low drilling costs, have made this area extremely attractive to the independents. The fields in the Denver-Julesburg area are apt to be small in extent but favorable in possibilities of oil recovery.

No. 1 Ruth Nicholson, Carter's fifth well, which pumped 153 bbl of 40.5 deg gravity oil in 24 hr is typical of the wells in the Merino pool.

Not only has the activity in the Basin raised the oil status of Colorado, but Nebraska, too, has moved up into fourth ranking state of the Rocky Mountain region in total drilling during 1951. Operators in the western portion of Nebraska drilled to completion 188 tests with 54 oil well completions, 14 gassers, and 120 dry holes.

In the near future, the Platte Pipe Line is expected to reach completion, raising the economic picture for Western Nebraska. In the past, production has been limited by difficulty in transportation to markets, but soon oil will move eastward through the Platte Valley Pipe Line.

Seismic exploration and geophysical activity reached an all-time high with a total of 712 crew weeks of gravimeter and seismic work, of which 622 were conducted in the Denver Basin area. In Colorado, 1467 crew weeks were conducted, the majority also in the Basin area.

European SEG to Meet

The European Association of Exploration Geophysicists will hold its second meeting in London on May 22 and 23. The European counterpart of the American SEG was founded by A. Van Weelden, Bataaesche Petroleum Maatschappij, during last December's World Petroleum Congress at The Hague. Van Weelden is president of the European association, and D. T. Germain-Jones, Anglo-Iranian Oil Company's research station at Kirklington Hall, Nottingshamshire, is vice-president. Nations represented in the council include Britain, Holland, France, and Germany. Headquarters are at 30 Carel Van Bylandtlaan, The Hague.

Alaskan Map Available

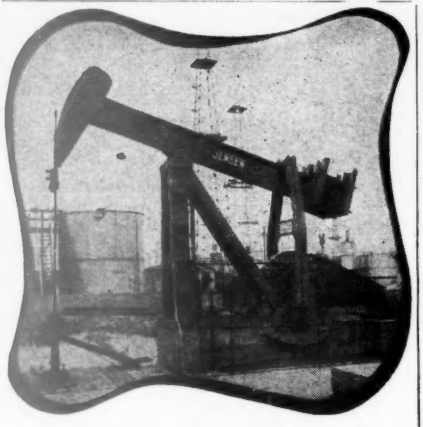
A comprehensive report of oil exploration and drilling in the Arctic Slope region of Alaska has been published by the Geological Survey. The region lies between the Arctic Ocean and the Brooks Range, and contains an oil reserve estimated at between 30,000,000 and 100,000,000 bbl.

The Navy has drilled 31 test wells in the region to date, two of which were drilled to a depth of more than 10,000 fit. In addition, 41 core tests have been drilled.

The report has been published as Oil and Gas Investigations Map OM 126, and shows locations of test wells drilled or under way as of March 1, 1951. It may be obtained from the Chief of Distribution, Geological Survey, Washington, D. C., for $1.50.

Rinehart 1952 Yearbook Out

Ira Rinehart's 1952 Yearbook, Volume 1 and 2, is now available. Volume 1 concerns the Mid-Continent area, and includes resume, maps, graphs, charts, and list of pools in each state in this area. Volume 2 contains the same information on the Rocky Mountain area. Price of both volumes to subscribers is $15, $12 for all additional copies; to non-subscribers, $25.



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Take a good look at this picture of a Jensen Pumping Unit. It *could* be on your well—saving you money with each nod of its walking beam.

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API Sets Oil Reserves up Five Billion Barrels

U. S. oil reserves reached an all-time high when the API estimated them at more than 5 billion bbl at end of 1951

More than 5 billion barrels of oil were added to the proved reserves of this country in 1951, according to an American Petroleum Institute report. Last year saw more wells drilled than any other year in history, 44, 826, but with the highest dry hole percentage in history. Record pre-war year was 1937, when 35,213 wells were drilled; however, 19 per cent were dry. For every foot drilled last year 29 bbl of reserves were added compared with 37 bbl in 1937.

New discoveries accounted for less than 10 per cent of the reserves added last year, 464,750,000 bbl out of more than 5 billion barrels of crude oil and natural gas liquids. Discoveries accounted for 25 per cent of 3,872,756,000 bbl of new reserves added in 1937.

New peaks were reached in proved reserves of liquid petroleum and natural gas last year; proved reserves of liquid petroleum rose from 29,536,061,000 bbl on December 31, 1950, to 32,192,633,000 bbl at the end of 1951, after deducting for an annual production of 2,481,373,000 bbl, net increase of 2.7 billion barrels. Natural gas reserves were 193.8 trillion cubic feet.

Of the 2.7 billion barrel net increase in liquid petroleum reserves, 2.2 billion barrels represented crude oil and 457,000,000 bbl represented natural gas liquids. Production of liquid petroleum in 1951 was estimated at 2.5 billion barrels, an increase of 310 million barrels over 1950. Production of natural gas was estimated at 8.0 trillion cubic feet, an increase of more than one trillion cubic feet over 1950's former record high.

The joint API-AGA report covers new discoveries, revisions of previous estimates and extensions of known pools. The proved reserves of liquid petroleum and natural gas referred to in the report apply only to those whose location and extent have been proved and measured. They do not include any estimate of oil or gas which may underlie vast untested acreage in the United States, which appears favorable to the accumulation of oil or gas.

Coming at a time when the American people are apprehensive about international tension and concerned about the country's internal strength and security, the joint announcement provides an inspiring report on the progessiveness and ability of the thousands upon thousands of men and companies who make up the vast petroleum industry.

The accompanying table shows proved reserves of crude oil, natural gas liquids, and liquid hydrocarbons.

The estimates in the API report, as in all previous annual reports of this committee, refer solely to proved or blocked-out reserves. They include only oil and natural gas liquids recoverable under existing economic and operating conditions.

The estimates made for this report by the committee do not include:

1. Oil* under the unproved portions of partly developed fields.
2. Oil in untested prospects.
3. Oil that may be present in unknown prospects in regions believed to be generally favorable.
4. Oil that may become available by fluid injection methods from fields where such methods have not yet been applied.
5. Oil that may become available through chemical processing of natural gas.
6. Oil that can be made from oil shale, coal, or other substitute sources.

Proved reserves considered in the report are both drilled and undrilled. The proved drilled reserves, in any pool, include the oil estimated to be recoverable by the production systems now in operation, whether with or without fluid injection, and from the area actually drilled up on the spacing pattern in vogue in that pool, the API committee stated. The proved undrilled reserves, in any pool, include reserves under undrilled spacing units which are so close, and so related, to the drilled units that there is every reasonable probability that they will produce when drilled.

This committee used the term "fluid injection" to include (1) what is commonly called "pressure maintenance"; (2) cycling; and (3) secondary recovery in its original sense, namely fluid injection applied relatively late in the development history of a reservoir (pool) with the purpose of stimulating petroleum production after recovery by primary methods of flowing and pump-

*The word "Oil" unless defined as crude oil, is used in this report as equivalent to liquid hydrocarbons.

TABLE 1. (a) Crude oil—API (barrels of 42 US gallons).

Total proved reserves of crude oil as of December 31, 1950		25,268,398,000
Revisions of previous estimates	+1,776,110,000	
Extensions of old pools	2,248,588,000	
New reserves discovered in 1951 in new fields and in new pools in old fields	389,256,000	
Proved reserves added in 1951		4,413,954,000
Total proved reserves as of December 31, 1950, plus new proved reserves added in 1951		29,682,352,000
Less production during 1951*		2,214,321,000
Total proved reserves of crude oil as of December 31, 1951		27,468,031,000
Increase in crude oil reserves during 1951		2,199,633,000

(b) Natural gas liquids—AGA and API (barrels of 42 US gallons).

Total proved reserves of natural gas liquids as of December 31, 1950		4,267,663,000
Revisions of previous estimates and extensions of old pools	+648,497,000	
New reserves discovered in 1951 in new fields and in new pools in old fields	75,494,000	
Proved reserves added in 1951		723,991,000
Total proved reserves as of December 31, 1950, plus new proved reserves added in 1951		4,991,654,000
Less production during 1951*		267,052,000
Total proved reserves of natural gas liquids as of December 31, 1951		4,724,602,000
Increase in Natural Gas Liquids reserves during 1951		456,939,000

(c) Total liquid hydrocarbons—API and AGA (tables 1a and 1b combined) (barrels of 42 US gallons).

Total proved reserves as of December 31, 1950		29,536,061,000
Revisions of previous estimates and extensions of old pools	+4,673,195,000	
New reserves discovered in 1951 in new fields and in new pools in old fields	464,750,000	
Proved reserves added in 1951		5,137,945,000
Total proved reserves as of December 31, 1950, plus new proved reserves added in 1951		34,674,006,000
Less production during 1951*		2,481,373,000
Total proved reserves of liquid hydrocarbons as of December 31, 1951		32,192,633,000
Increase in Total Liquid Hydrocarbon reserves during 1951		2,656,572,000

*The 1951 production figures were compiled by the committee and where necessary are based on 11 months actual production with an estimate for December. Any variance between the actual production, as later reported, and the figures used herein will be compensated for through revision when the following year's reserve report is compiled. These revisions have in the past been very small.

ing has approached an economic limit. The reserves that may become available as a result of fluid injection are regarded as *proved only* after thorough testing by a pilot plant, or better after operation of an installed fluid injection procedure, has actually demonstrated certainty of increased recovery. Then, and only then, are such reserves included in the API committee's estimates of proved reserves.

In the case of new discoveries, both of new fields and of new pools (pays, reservoirs) in old fields, which are seldom fully developed in the first year and in fact for several years thereafter, the estimates of proved reserves necessarily represent but a part of the reserves that may ultimately be assigned to the new reservoirs discovered each year.

For a one-well field, where development has not yet gone beyond the discovery well, the area assigned as proved is usually small in regions of complex geological conditions but may be larger where the geology is relatively simple. In a sparsely drilled pool the area between wells is considered to be proved only if geological and engineering data assure that such area will produce when drilled.

The total of new oil through discoveries estimated as proved in each year is comparatively small, because development is usually not extensive during the first year. The total of new oil through extensions, on the other hand, is comparatively large. As knowledge of the factors affecting production and reservoir performance becomes available, and as these factors are studied, reserves in old fields can be estimated with greater precision and revised accordingly. Therefore, the total quantity of the new proved reserves for the year includes the oil from discoveries and extensions, modified by revisions of previous estimates where new data have made better information available.

The committee again wishes especially to stress the fact that its estimates of proved reserves cannot be used in measuring the rate at which these reserves can be produced with or without physical waste. Oil cannot be produced from the permeable rocks in which it occurs at any desired rate, the API group emphasized, because the flow of oil through the pores of the oil-bearing rocks is definitely controlled by the physical factors of the reservoir. As a matter of fact, today's known oil can be recovered only over a period of many years and at gradually declining annual rates. This has been widely demonstrated by past performance under all kinds of operating conditions. Therefore, only incorrect conclusions as to the life of these reservoirs can be obtained by dividing these reserves by the current rate of production.

The committee on petroleum reserves consists of F. H. Lahee, Sun Oil, chairman; D. V. Carter, Magnolia Petroleum, vice chairman; Fred Van Covern, API, secretary; R. F. Baker, The Texas Company; Frank R. Clark, Ohio Oil; Morgan J. Davis, Humble Oil and Refining; Graham B. Moody, Standard Oil California; Morris Muskat, Gulf Oil; J. M. Sands, Phillips Petroleum; P. R. Schultz, Stanolind Oil and Gas, and Theron Wasson, Pure Oil. * * *

Texas Reserves Rank High

Texas oil reserves totaled 18.2 billion barrels at the end of 1951, accounting for 56.5 per cent of the nation's underground storage of crude oil and petroleum liquids from natural gas. These record figures were revealed in a state analysis by the Texas Mid-Continent Oil and Gas Association of a report on domestic reserves released by the American Petroleum Institute and the American Gas Association.

Texas has long led the list in reserves and production, but its national importance oilwise was sharply accelerated in 1951.

"Eight out of every 10 bbl of oil added to the reserves of this country last year were found in Texas," R. F. Windfohr, association president, pointed out. A net increase in reserves of 2.1 billion barrels was noted after accounting for 1951's record withdrawals of 1.1 billion barrels. The 1951 additions to reserves were 79.6 per cent of the nationwide increase. The year before, Texas oil men accounted for about one-third of the national additions to reserve.

Swiss Attempt to Recover Oil from Alberta Tar Sand

A team of Swedish scientists are reported in Alberta, Canada, seeking to recover oil from the Athabasca tar sands without the labor and expense of mining the sand. Details of the process have not been disclosed.

The oil, almost as thick and heavy in its natural state as tar, is mixed with sand in a bed 100 to 200 ft thick and from 8000 to 30,000 sq miles in extent. Chief obstacle to commercial development has been economical separation of the oil from the sand.

Socony 1951 Oil Output Up

Socony-Vacuum Oil Company, Inc., has released final 1951 figures showing a record net production of 76,000,000 bbl of crude oil in the United States last year. Averaging 209,000 bbl a day, the total exceeded that of 1950 by 15 per cent.

Despite these withdrawals, the company increased its domestic estimated proved reserves of crude oil and condensates by 159,000,000 bbl to a total, at year's end, of 1,650,000,000 bbl.

Sapphire Well Drilled

Julien B. Adoue, vice president of Sapphire Petroleums Limited, has announced that Padgett No. 4, the first well drilled on the Kansas site recently acquired by Sapphire and Harman Oils and Minerals Ltd., has been allowed 50 bbl per day. He added that another well will be started immediately and stated that he believes this is the first well brought in by a Canadian company in the United States.

Dry Chemicals Extinguish Oil Fire in Venezuela

A spectacular oil well fire that raged unchecked for five days in the Las Mercedes oil fields of Sociedad Anonima Petrolera Las Mercedes in Venezuela (an affiliate of The Texas Company) was extinguished recently by dry chemical fire extinguishers in exactly 5[illegible] sec.

Details of the extinguishment were received by the Ansul Chemical Company whose equipment was used.

The Las Mercedes fire occurred when an electric spark freakishly ignited some surface gas. The resulting blowout around the outside of the well casing tossed mud, rocks, water, and gas 30 ft into the air. After preliminary attempts at extinguishment by foam, water, and carbon dioxide failed, the company summoned outside help by radio, and six Ansul 150-lb wheeled units were sped to the scene.

Because of the time required to obtain the necessary wheeled units, no further attempt was made to extinguish the fire until the morning of the fifth day. By that time, the gas pressure, plus the erupting water and rocks, had formed a large crater 50 ft in diameter and 25 ft deep where the drilling rig once stood.

By direction of Paul Bunke, acting superintendent at Las Mercedes, the entire well area was cleared of all metal and equipment in preparation for extinguishment. Then bull dozers threw up a large dike in a semi-circle around part of the crater. At 10 a.m., an attempt was made to extinguish the fire by steam piped to the crater area from two powerful boilers, but this did not achieve extinguishment. Water was then brought to play on the area for cooling purposes.

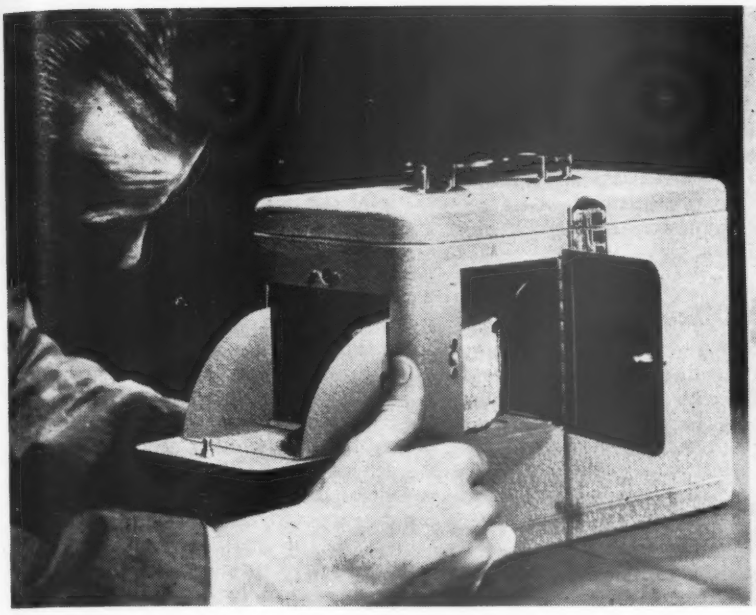
Meanwhile six Ansul dry chemical units had been placed in a semi-circle behind the earthen dike. At 10:00 a.m., the water hoses were diverted from the fire. The fire was attacked with dry chemical. Fifty seconds later, the fire was out.

Exploration Firm Set Up

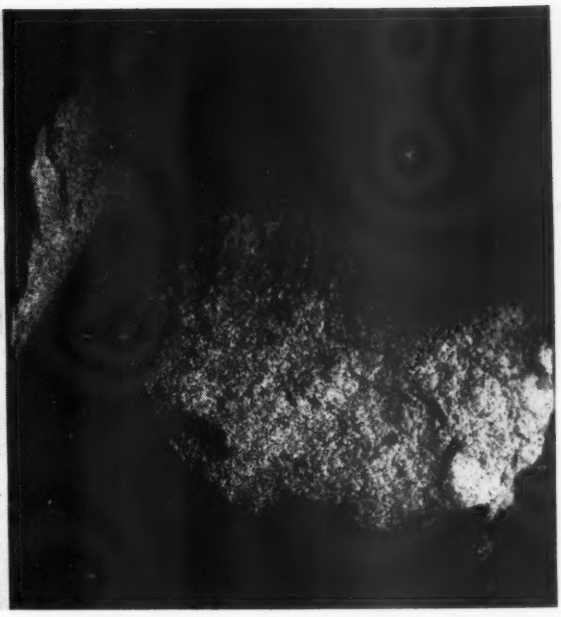
Dr. Victor Ziegler, Denver, Colorado, geologist, has formed the Ziegler Exploration Company with offices in Denver. Former owner of the Bonanza Oil Company, Ziegler announced that the company will operate in Montana, Wyoming, and Texas.

Kuwait's 1951 Oil Output Is 63 Per Cent Above 1950

Kuwait's oil production last year was 63 per cent above the 1950 average, according to figures released by Gulf Oil Corporation. Crude oil output totaled 205,585,000 bbl, compared with 125,938,000 bbl the previous year. In December, Kuwait's oil production averaged 675,630 bbl daily, or 67 per cent greater than December, 1950. Kuwait Oil Company, which holds the oil concessions in Kuwait, is jointly owned by Gulf Oil and Anglo-Iranian Oil.



The Mineralight SL 3600, with the 404 carrying case, is being used here to analyze a core. The SL 3600 operates on 110 volt a-c or d-c (with an adapter) and has space for two 45-volt "B" batteries.



Under long wave ultra violet, oil traces are indicated by fluorescent glow. Color differences in fluorescence indicate which zones of core are oil-bearing.

BLACK LIGHT AIDS OIL EXPLORATION

Long wave ultra-violet is being used in examination of cores and samples as well as in testing surface soil

MORE and more searchers for black gold are using black light* in their exploration. The fluorescence of petroleum under long wave ultra-violet lamps in some cases permits direct prospecting. The slightest trace of oil—in concentration as low as a few parts per million—will fluoresce. The effect is observable even if oil is diluted with mud or water, or dispersed throughout the sample, cutting, or core.

Most spectacular of the ultra-violet exploration techniques is the testing of surface soil samples. A particular fluorescence in top soil indicates that petroleum is present hundreds of feet below! The characteristic oil-indicating color is caused by certain soil bacteria. Hydrocarbon gases, diffused upward from the oil deposit, act upon the microorganisms and are changed into fluorescent substances that spread through surface earth.

*Ultra-Violet Products, Inc., Pasadena, California.

A preliminary study of surface fluorescence often indicates the advisability of continued exploration with other methods.

In addition to detecting the existence of oil, long wave ultra-violet lamps can tell the geologist a great deal about the drill core with which he is working. Color differences in fluorescence indicate which zones of the core are oil-bearing, distinguish between oil and gas-producing strata. Little or no fluoresence in a core zone indicates a dry gas or salt water producing formation.

Value of the long wave ultra-violet lamp is heightened by the fact that no two samples of petroleum emit exactly the same fluoresence. Color and brightness differ, whether the oil is from different zones of the same drilling, or from a well in a different location.

It is clear why an ultra-violet lamp is becoming an essential geologist's field instrument, when results of its use in a Louisiana field are cited. In this field, a long wave lamp, the Mineralight SL 3660, was used on six wells. It gave correct information on about 50 cores containing six or more gas-oil or oil-water contacts.

Similar accurate results have been reported by geologists working in many other fields.

As borderline tests are not uncommon, increased accuracy may be gained by using a short wave lamp in conjunction with black light. The short wave ultra-violet had added value in indicating the presence of minerals, such as tungsten, zinc, and uranium ores.

In all testing with ultra-violet light, fresh breaks are examined, because of the tendency of samples to oxidize.

A highly serviceable, long-wave, ultra violet unit has been manufactured that operates on 110 volt a-c or d-c, and has space for two 45 volt "B" batteries. This gives the explorer a complete three-way lamp and a carrying case, including the daylight viewing compartment. * * *

NEWS

AIOC's English Fields Producing Rate High

Anglo-Iranian's English oil fields production totaled 5,355,000 bbl of oil in February, according to the Anglo-Iranian Oil Company. Production from these fields began in 1938, with 2 bbl a day being produced. Peak year for the fields was in 1943, with a production of 2255 bbl a day. Lately production has been at the rate of about 1000 bbl a day. The fields are situated around Eakring, Nottinghamshire, and Formby, Lancashire.

IOCC Publishes Booklet on Illinois Water Flooding

The Interstate Oil Compact Commission has announced publication of "Summary of Water-Flooding Operations in Illinois to 1951", a joint survey by the state of Illinois and the Interstate Oil Compact Commission carried on by the Secondary Recovery Study Committee for Illinois with Frederick Squires, chairman, in cooperation with the secondary recovery division of the IOCC. This study gives summary data on 63 controlled water floods in Illinois as of January 1, 1951. In addition, more detailed information is given on the Benton unit, the South Johnson water flood, and the Salem unit together with a short resume of water supply. This publication is the second report prepared by this Committee.

From the data assembled, total production for all floods during 1950 was 4,607,154 bbl of oil with a total water injection of 50,053,838 bbl. The accumulative recovery from all water floods in Illinois is given as 20,325,584 bbl to January 1, 1951, and the total water injected is given as 124,039,684 bbl.

Copies of the pamphlet have been reprinted for distribution as Circular 176 of the Illinois Geological Survey entitled "Summary of Water-Flooding Operations in Illinois Oil Pools to 1951." A copy of the publication can be obtained by a request to the IOCC, Box 3127, Oklahoma City.

Alabama Offices Opened

Humble Oil and Refining Company has opened new district offices at Brewton, Alabama, with H. Durst in charge. With Durst is Jack Van Zandt, chief district clerk.

L. A. Nomads Hold Annual Inaugural Ball

Past presidents of the Los Angeles Chapter of Nomads were awarded framed scrolls and gavels engraved with their names and terms of office at the 13th annual inaugural ball held at the Ambassador Hotel recently. In top picture are: H. W. Pullman, W. F. Bettis, E. B. Fowks, T. Sutter, E. L. Decker, J. A. Engstrand, R. J. Eiche, F. C. Ripley, L. J. Laird, and E. M. Boggess. Not shown are Roland E. Smith and Elmer R. Smith who are out of the country.

New officers of the Los Angeles Nomads are here shown (bottom photo) at the inaugural ball. They are: John W. Rife, who resigned recently as executive secretary; R. W. Craig, assistant secretary; James D. Hughes, secretary; J. A. Engstrand, retiring president; W. A. Wilson, newly elected president; H. J. Schlarb, deputy sergeant-at-arms; John H. Flanagan, treasurer; and B. E. Mater, assistant treasurer. Not shown: Earle H. Rees, former president and W. H. Sargent, sergeant-at-arms.

Spraberry Trend May Cover 1,000,000 Acres, API Told

Discoveries so far in the Spraberry Trend of West Texas indicate the possibility of one continuous oil reservoir covering more than 1,000,000 acres, two prominent oilmen told the Southwestern district division of production meeting of the American Petroleum Institute.

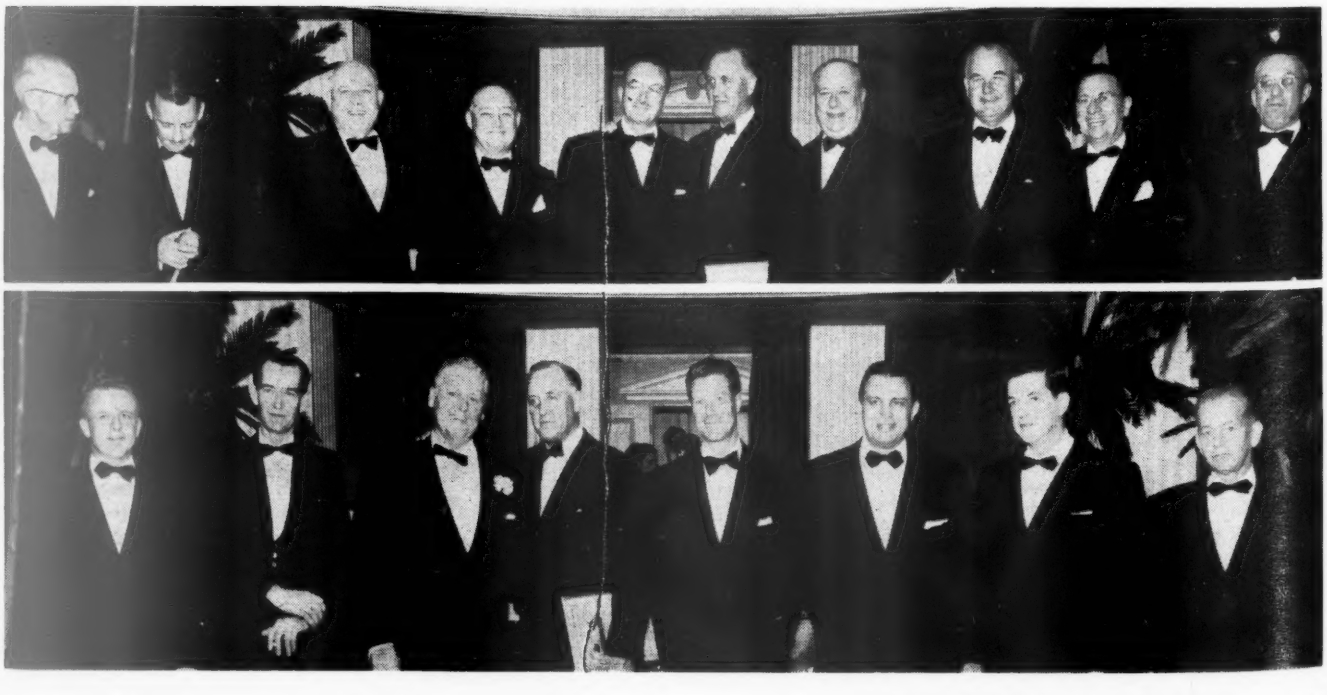
R. S. Christie, Tulsa, and J. C. Blackwood, Midland, Texas, delivered a paper on the Spraberry Trend before the API meeting, which stated that it will take several more years to develop the area. Their reasons were that quality of a part of the reservoir was poor and shortages of steel and other needed materials.

Christie and Blackwood, officials of Amerada Petroleum Corporation, also pointed out that wells will go on artificial lift in their early life and that recoveries by primary method will be low. Prospects by secondary recovery methods are not promising now, they said.

Two other papers on Spraberry were delivered during the meeting. J. H. Bartley, consulting geologist, Midland, in outlining the geology of the area, said it's developing into the world's largest oil field. Bartley reported that as of last February 16, approximately three years after first Spraberry production, there were 1072 producing wells distributed throughout 20 producing areas. From this section has come a total of 24,600,000 bbl of oil, or more than an average of 2,000,000 bbl per month.

Leonard O. Franklin, Midland, Magnolia Petroleum Company, who delivered the third paper on Spraberry, said that development of the trend is continuing at a "rapid pace." He said a number of drilling and completion practices are being employed "by many operators in an attempt to complete wells at a reasonable cost while realizing the maximum ultimate recovery."

Los Angeles Nomads at annual inaugural ball.

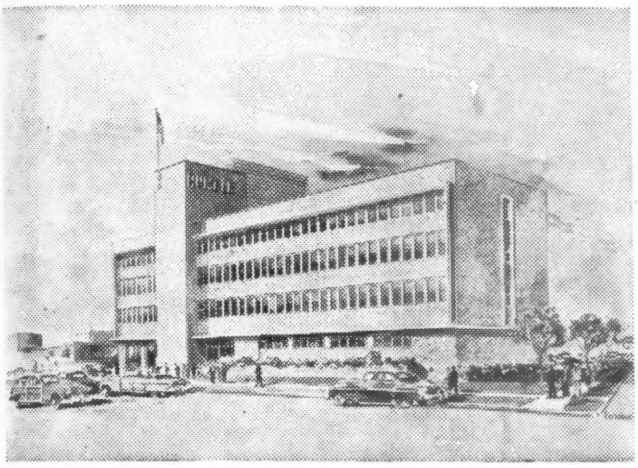


Texaco Builds New Laboratory

A two-story laboratory building for the research division of the producing department, The Texas Company, is being erected at Bellaire, Texas, east of and adjacent to the producing laboratory building.

Of brick veneer construction on a reinforced concrete frame, the building is 40 ft in width and 170 ft in length. The first floor will be partitioned into 10 laboratory rooms with adjoining offices and a large auditorium and a library with folding doors that may be opened to increase the seating capacity of the auditorium.

On the second floor will be offices, laboratories, and the drafting department.



Humble's Midland Offices. Humble Oil and Refining Company held formal opening of its new four-story office building in Midland, Texas, recently. The building contains 48,000 sq ft of floor space, and is designed to allow for addition of three more stories.

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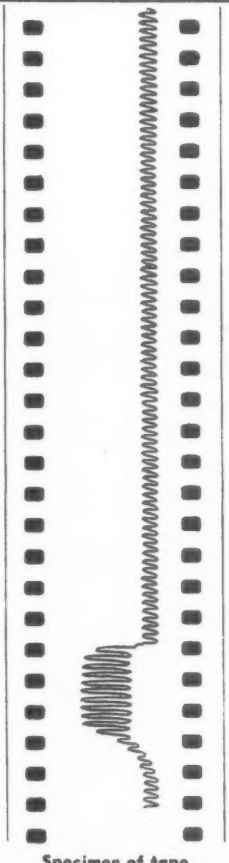

Specimen of tape indicating saturation

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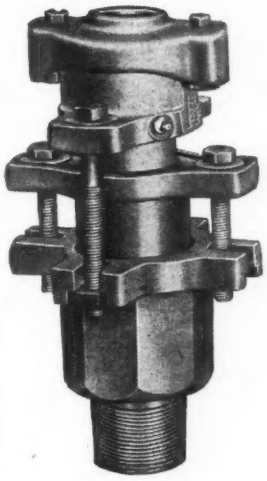

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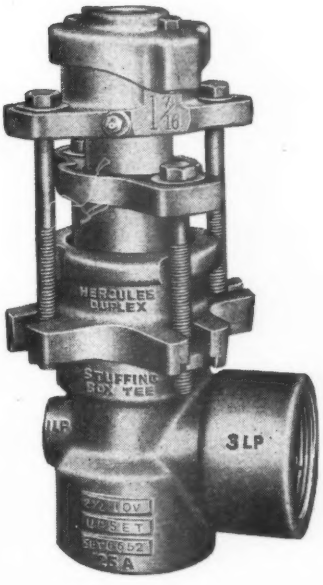
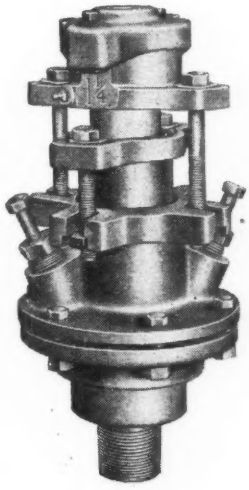
The Tee-Base Type Combination Stuffing Box and Tee (directly below) have been proven by years of service and savings to producers. Write for Bulletin 121-SBT.

A double packed Stuffing Box for use under most adverse pumping and flowing conditions (below). Be sure to order Type A-123-SBDP.





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Farrand Explains PAD Steel Allotment Plan

An explication of the PAD foreign production program for the current year was the feature address by W. H. Farrand at the regular dinner meeting of the Los Angeles Chapter of Nomads recently. Prior to this address was the showing of a moving picture, "Budweiser Champion Clydesdales," by Dick O'Shanesy and Harry Sperb who were introduced by Bob Eiche.

The speaker of the evening, Bill Farrand, was introduced by W. H. (Bill) Sargent of Sargent Engineering Corporation. He stated that even prior to Korea some American companies were having difficulty in purchasing enough oil country tubular goods to satisfy their requirements and then reviewed the situation that has obtained since.

During the third quarter of 1951 the Controlled Materials Plan was put into operation and the procedure of allocation of materials was changed. As regards foreign shipment of materials, simply stated "the foreign petroleum companies apply to OIT for the amounts of controlled materials required. These amounts are added up and screened by PAD and are used for estimate needs. The total is examined by the Foreign Petroleum Materials Committee and compared with the program of operations as compiled by PAD and with the requirements justifications, program, past due and inventory as submitted by the companies and as known to PAD.

"The Foreign Materials Committee then revises and approves the proposed requirement developed by the PAD in the light of the program. The request for allotment of the materials then goes forward to DAP through ECA-OIT and separately by PAD."

Farrand remarked that "We in the PAD are almost acting in the capacity of lawyers in that we represent the industry to see that their claims for materials are well presented and we try to get the purchasing and supplying clients together to accomplish this program. We endeavor to serve the industry to the best of our ability."

In reviewing the production situation world wide, Farrand pointed out that "many areas are now devoting practically 100 per cent of their activity to maintaining their current production rates. Some such areas are Trinidad, Peru, Argentina, and, for practical purposes, Colombia, although the latter country shows a slight increase in 1951. In the Far East, Indonesia showed little increase in 1951 but British Borneo increased about 20,000 bbl per day. The areas showing the greatest increases are Canada, which increased about 100,000 bbl per day; Venezuela, which increased about 200,000 bbl per day; and the Middle East, which increased 159,000 bbl per day despite the shutting in of Iran.

"From this quick review, it is apparent that there are not many areas that may be expected to contribute increases for the 1952 program; however, we have calculated that the Western Hemisphere could increase 138,000 bbl per day if the drilling program were carried out. About 20,000 bbl per day would come from Canada, 106,000 bbl per day from Venezuela, 10,000 bbl per day from Colombia and a couple of thousand barrels from the rest of the Western Hemisphere.

"In the Eastern Hemisphere, exclusive of Iran, we estimated that Iraq would increase 80,000 bbl per day, Indonesia 20,000 bbl per day, the Middle East as a whole 167,000 bbl per day, and North Africa and other areas approximately 3000 bbl per day. We thus calculated that the Eastern Hemisphere would step up its production 270,000 bbl per day.

"As regards the drilling, Canada would drill on the order of 2000 wells; Venezuela 1424 wells; Mexico 482 wells; Peru 275 wells; Argentina 246 wells, and the rest of the hemisphere 464, totalling 4891 wells for North and South America, exclusive of the U. S. It was calculated that the Middle East would drill 153 wells; India and Pakistan 52 wells; the Far East 274 wells; Europe 67 wells, and the other countries 6 wells. This makes a total for Eastern Hemisphere of 552 wells. The total of 5443 wells compares with 4352 wells drilled in the same areas in 1951, an increase of 1091 wells or 25 per cent."

Seated: Charles T. Blanchet, Cal-Tex. NPPM; W. H. Farrand (speaker), Foreign Production Division, PAD; Maurice Genini, Societe Cherifieme des Petrole, Rabat, French Morocco. Standing: Joe Atkins, Basrah Petroleum Company, Iraq; A. F. (Hoopie) Driskill, Iraq Petroleum; J. Jack Parks, Mene Grande Oil Company, en route to Venezuela. Not in picture, F. H. Kopp, Aramco Oil Company.

Charles H. Moore, Jr.

Canadian Geophysical Firm Established in Canada

Formation of Geophysical Service International Corporation, 706 Ninth Avenue West, Calgary, Alberta, Canada, has been announced. The company has taken over all operations of Geophysical Service, Inc., in the Dominion of Canada and will be under the resident direction of Charles H. Moore, Jr., vice president and manager. Supervisory personnel include T. A. Halbrook, E. A. Kiesler, R. H. Rainey, and J. L. Stephens. W. E. Dickson is equipment supervisor and Jack L. Clark continues as office manager.

Other officers, stationed in Dallas, Texas, include H. B. Peacock, chairman; Cecil H. Green, president; F. J. Agnich, executive vice president; K. E. Burg and R. C. Dunlap, Jr., vice presidents; J. E. Jonsson, treasurer; W. C. Edwards, Jr., secretary.

North Dakota Sets Up Well Spacing Pattern

The State Industrial Commission of North Dakota has rejected Amerada Petroleum Corporation's petition to carry out its 1953 exploratory program in Williams County on a 1-to-80 acre pattern.

Spacing in the Beaver Lodge pool will remain 1 well to 40 acres. Commissioner of Agriculture and Labor Math Dahl and Attorney General Elmo Christianson voted for rejection; Gov. Norman Brunsdale favored a temporary 80-acre pattern until more information is gathered on the pool.

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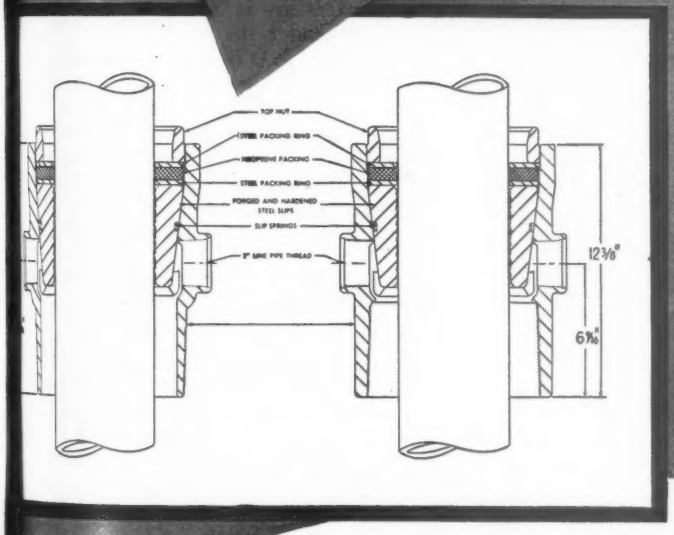
Specify LARKIN CASING HEADS

The Larkin Casing Head is designed to provide a safe and economical means of suspending and packing off casing strings in wells of medium depth and pressure. Simplicity and compactness, for ease of installation and neatness of hookup, are also incorporated in its design.

The unique ribbed internal construction of the Larkin Casing Head Body, with no sacrifice in strength, provides the greatest possible fluid opening from the casing annulus to the 2" side outlets. Centralizers and Cementrol equipment pass through the head freely.



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3. Oil and Wear Resistant Neoprene Packing
4. Tested to 2000 lbs. per square inch Hydraulic Pressure
5. Designed for free passage of centralizers and Cementrol equipment

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WHAT'S DOING IN DRILLING

Continental Well Flows 1925 Bbl of Oil Daily

The Elkhorn field of Crockett County, West Texas, has been extended ½-mile northwest by Continental Oil Company with completion of its No. 11-A Shannon. The new well was completed for a calculated daily flowing potential of 1,925.67 bbl of oil with gas oil ratio of 525 to 1. Potential was based on actual flow of 561.67 bbl of oil in 7 hr, through 4/64-in. tubing choke. Perforations were made between 7292-7260 ft in 5½-in. casing cemented at 7342 ft.

Lion Completes Small Mississippi Pumping Well

Lion Oil Company has completed a small pumping well in the Freewoods field of Franklin County, southwestern Mississippi. The new well is Lion's Thomas No. 3, which had an initial production rate of 27 bbl of 39 gravity oil per day, plus 413 bbl of salt water. Flow is from perforations between 6482-96 ft. Hole was bottomed at 6613 ft, and is cased with 5½-in. pipe to 6566 ft.

Shell Brings in Well In Elk City Field

Shell Oil Company's No. 2 Fender "C" has been brought in in the Beckham County, Oklahoma, sector of the Elk City field. The oil and gas producer has a plugged back depth of 10,600 ft, and flowed 406 bbl of 48.1 gravity oil in 24 hr through a 28/64-in choke from perforations between 9870-9910 ft. Gas-oil ratio was 2842 to 1.

Dollarhide Field Extended

A quarter-mile extension of the Dollarhide field of Andrews County, Texas, was indicated recently when Cities Service Oil Company's Cowden P No. 1 flowed 160 bbl of oil during a four-hour drillstem test in the Devonian limestone from 8346 to 8435 ft.

Shell to Open New Office In Salt Lake City, Utah

Shell Oil Company is establishing a district office in Salt Lake City, Utah, according to an announcement by J. E. Clark, Rocky Mountain division manager for the company in Casper, Wyoming. The new district will be responsible for the company's exploration activities in northeastern Utah.

It is the third one to be opened since Shell began preliminary exploratory work nine years ago in the Rocky Mountain region. Other district offices under division headquarters at Casper are located at Billings, Montana, and Grand Junction, Colorado.

W. W. Woodward has been appointed district geologist and will be in charge of the new Salt Lake office. Prior to this assignment, Woodward was stationed in California and Nevada. D. O. Cole, district leaseman from Casper, will be in charge of land activities in the new district.

Hamon Well Opens New Zone

Jake L. Hamon, Dallas independent operator, has added a new producing zone to the Beaver pool in Stephens County, Oklahoma, where his No. 1 Wahahrockah has proved productive on tests. Hamon made 8 drillstem tests beginning at 7087 ft, with shows ranging from 42 gravity crude to white distillate. First test, a 45-min opening at 7087 to 7100 ft had gas in 3 min at 1,000,000 ft per day, and recovered 590 ft of 42 gravity oil.

Kansas Field Well

An extension of the Christina pool of Ellis County, Kansas, was indicated when the Cities Service Ginther No. 2 filled up 2565 ft with oil. The well topped the Arbuckle at 3419 ft and 5½-in. casing was set at 3420 ft. Total depth is 3427 ft. Operators are preparing to make production tests.

Large Producer Drilled in East Happy Valley Pool

Olson Oil Company has completed a new producer in the East Happy Valley pool. It is his No. 1 Edna Wolff in Payne County, Oklahoma, which flowed 50 bbl of 42 gravity oil an hour for 4 hours through 2-in. tubing. Total depth of the well was 3336 ft in the Bartlesville sand. It was placed on a ¼-in. choke and flowed 119 bbl of oil in 12 hr. The new producer, which is completed, is said to be the largest producer in the pool.

Jergins Oil Changes Name

The corporate name of Jergins Oil Company of Texas became Monterey Oil Company of Texas, recently, a change in name only, involving no change in business or operations of the company.

The company's activities are carried on principally in Southwest Texas. Headquarters are in San Antonio, with operations under the immediate direction of Jerome J. O'Brien, vice president and general manager.

The company has production and active development operations on its properties in the Helen Gohlke (Wilcox) field, the South Coletto Creek field, the Cologne area of Victoria County, and in the McKee area of Crane County, Texas.

Arabian American Reports Saudi Arabia's Oil Output

Crude oil production in Saudi Arabia during February amounted to 25,081,455 bbl, or an average of 864,878 bbl per calendar day, it was announced by Arabian American Oil Company. This was comparable to 26,464,058 bbl produced in January, an average of 853,679 bbl per calendar day.

Crude oil production for the first two months of 1952 amounted to 51,545,513 bbl, an average of 859,092 bbl per calendar day.

General Crude Brings in West Texas Field Well

General Crude Oil Company has brought in a new well in the Claytonville field of Fisher County, West Texas. The well hit the Canyon Reef oil producing zone about 120 ft higher than the company's original discovery well in this field, with completion made from an open hole section at 5623 ft to 5647 ft. The No. 2 Webb, with a total producing section of about 200 ft, flowed at the rate of 20 bbl an hour on production test for an indicated daily potential flow of 480 bbl. Canyon Reef was topped at about 5450 ft.

Rotary Rigs Operating in Oil Fields of United States and Canada*

Weeks	Total	Gulf Coast	Pacific Coast	Illinois Oklahoma Kansas	Rocky Mountain Canada	New Mexico West Texas	North Texas
(February)							
Fourth	2879	589	173	586	336	703	334
(March)							
First	2845	584	170	588	339	693	319
Second	2839	604	168	545	341	690	337
Third	2892	609	158	566	349	718	337

*As reported to the American Association of Oilwell Drilling Contractors by Hughes Tool Company.

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Whether you're down deep, or want a greater safety margin on routine jobs, it's plain good business judgment to insist on the cement that gives you this reliable 3-way protection:

EASY PUMPING—Unaflo's high *initial* fluidity makes pumping easier right from the start.

SUSTAINED FLUIDITY—Unaflo isn't just "slow-setting." It's a retarded cement and *stays* fluid and pumpable throughout the retardation period.

HARDENS NORMALLY—Unaflo, after its retarded period, makes a strong, tight seal—resistant to sulfate waters.

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Resistant to Sulfate Waters
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PE-U-125

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Texas' Jud Field Gets Dual-Zone Producer

Rowan and Hope have proved a new producing zone in the West Jud field in Haskell County, Texas, with completion of a dual zone producer. Their No. 3 Anna Mae Hutchison has been completed from the Strawn sand and the Bend conglomerate, the new zone. From the Bend at 5821-25 the well made 173.3 bbl per day through 15/64-in. choke with gas-oil ratio 656 to 1. It gaged 138.3 bbl daily through 17/64-in. choke from the Strawn at 4972-84 ft.

Fruitvale Field Extended

York and Associates have completed a new well in the Fruitvale field of Los Angeles, California, which has been under development for almost 24 years. Latest well is the No. 1 Duke, which has been drilled as a link between two extension wells drilled last year. It has been completed flowing 160 bbl daily in the Kernco through perforations at 4330-60 ft.

Benoist Sand Zone Found in Indiana

Bury Drilling Company has completed its No. 1 Freeman, confirming its recent discovery of Benoist sand production in Gibson County, Indiana. The new well is being completed at a total depth of 1580 ft. Casing is bottomed on top the producing zone at 1509, and on a drillstem test 200 ft of clean oil were recovered with an indicated bottom hole pressure of 580 psi. Additional saturation at 1560-70 ft was not tested. Benoist sand is a new zone for the general area.

Ohio Oil Pool Given Two New Oil Wells

Preston Oil Company has added a new producer to the New Castle pool in Coshocton County, Ohio. It is the No. 5 Charles Richards, which flowed 40 bbl natural from Clinton sand at 3332-3379 ft, and increased to 100 bbl in 24 hr after a 60 qt shot. A second well has been added to the field, the Oxford Oil No. 1 Wm. Frazee. This well flowed 30 bbl in 24 hr after being shot, from a depth of 3223-3233 ft.

Sohio Adds Well to Pool

Sohio Petroleum Company has a two-mile east-southeast extension to production in the southwestern Glasscock County, section of the Driver-Spraberry field of West Texas. The No. 2 E. P. Williams, flowed 510.34 bbl of oil through a 3-in. choke in 15 hours. Flow was from a fractured lower Spraberry section between 7652-7710 ft.

Alabama Well Abandoned

Humble Oil and Refining Company has plugged and abandoned its No. 1 H. D. Finley, et al, in the Pollard field, Escambia, Alabama. Site of the well is approximately ¾ of a mile southeast of the discovery producer for the field. The well was abandoned at 6510 ft.

Humble Well Confirms Oil Pool in Louisiana

Humble Oil and Refining Company has confirmed production in the Bayou Jean LaCroix field of Terrebonne Parish, Louisiana. The No. 1 LaTerre Company, Inc., "D" on latest test flowed at the rate of 288 bbl of 35.1 gravity oil daily through ⅛-in. choke. Production is from perforations at 12,526-31 ft, and tubing pressure on the test registered 3500 psi. It is bottomed at 13,195 ft.

New Well in Kentucky Field

Stanford Oil Company has found good saturation in the McClosky lime at its Annie Stewart heirs in the Spottsville pool, Henderson County, Kentucky. On a 60-min drillstem test of the interval between 2252-56 ft, 2000 ft of clean oil and 40 ft of oil-cut mud were recovered, with a bottom-hole pressure of 780 psi. The hole has been drilled to 2315 ft and casing run through the zone. Other production in this pool has been from the Aux Vases lime.

New Zone in Konawa Field

Absher and Booth of Tulsa, Oklahoma, have found a new producing zone in the old Konawa field in Seminole County, Oklahoma. Their No. 1 Amasson, a step-out west of the Konawa field, found porostiy in the Simpson Dolomite, and on drillstem test between 3868 and 3873 ft recovered 140 ft of oil and 120 ft of oil-cut mud. Production from the Konawa is from the Cromwell.

Sohio Hits McLish Zone

McLish production has been proved by Sohio Petroleum Company at its No. 1 Henthorne, an extension to the Eola pool of Garvin County, Oklahoma. Carried to the McLish, topped at 8725 ft, a drillstem test between 8775-8882 ft had gas in 8 min and oil in 13 min of a 4¼-hr test. Turned to tanks in 18 min, the well flowed 65 bbl an hour through ½-in. chokes. When the well was opened at top to 1⅛-in. choke with ½-in. bottom choke, the well flowed 297 bbl of 34.9 gravity oil in 3 hr, flowing as high as 102 bbl an hour during the test.

Sun Oil Drills Field Well

Sun Oil Company has drilled a new well in the northeast Mammoth field of Lincoln County, Oklahoma. It is the company's No. 3 Brunt, testing open hole in the Skinner sand. The new well produced 70 bbl of oil in four hours through 14/64-in. choke from pay at 4573-90 ft.

Tex Harvey Field Gets Well

Anderson Prichard Oil Corporation has extended the Tex Harvey field in Midland County, West Texas, ¾ mile with its No. 1 H. L. Hunt. A daily flowing potential of 877 bbl of 39 gravity oil from perforations in both the upper and lower Spraberry was filed by Anderson Prichard Oil. Flow is from a ¾-in. choke. Spraberry was topped at 7110 ft, with total depth at 8035 ft.

Colorado Field Given New Producing Zone

Mountain Fuel Supply Company has a new zone discovery at its No. 1 Unit in the center of the Hiawatha field, Logan County, Colorado. The well has been drilled to the Nuggett at 14,702 ft, total depth, and failed to produce from lower sands. At this depth it established a record for depth in Colorado. The well has been plugged back to 4988 ft, with casing below that depth, and perforated the zone, 4885-4930 ft, completing with a flow of 9,000,000 cu ft daily.

Well Potential Set at 1712 Bbl Oil a Day

Continental Oil Company has completed a producing oil well in Aspermont Lake pool, Stonewall County, Texas. It is the company's No. 1 Viertel, which flowed 784 bbl of oil, with no water, through a 1-in. choke in 11 hr. The well was given a potential production of 1712 bbl a day of 42.7 gravity oil. Total depth is 4944 ft. Continental owns the well with Drillers, Inc.

Kanotex Refining Well Added to Guelph Field

Kanotex Refining Company has given the Guelph field in Sumner County, Kansas, a new producing horizon. The well is the company's No. 4 Guelph, which flowed its potential of 98 bbl of oil daily. Other production in the field is from the Lansing-Kansas City lime and Simpson sand.

Kansas Field Well Success

Continental Oil Company has completed its No. 2 George Gillespie in the Northwest Adell pool, Decatur County, Kansas. The new well, drilled to a total depth of 3824 ft in Lansing limestone, has 39 gravity oil; its initial potential is 1247 bbl per day.

Pine Mills Field Gets Well

A new well has been drilled in the Pine Mills field, Southern Wood County, Texas. It is the L. A. Grelling's No. 2 O. M. Childress, confirmation well of the field. The well is flowing at the rate of 396 bbl of 30.2 gravity oil a day through ¼-in. tubing choke. Hole was carried to a total depth of 7940 ft and 5½-in. casing was cemented at 7919 ft. Flowing tubing pressure was 340 lb, casing pressure, 270 lb.

Tinsley Field Well Success

Tinsley field of Yazoo County, Mississippi, has been given a good pumping well at Jones-O'Brien's No. B-4 Jennie Stevens. The well has been completed pumping at the rate of 288 bbl of 39.4 gravity oil per day based on a 12-hour test. No formation water was present. On a drillstem test, the well flowed at the rate of 6 bbl of oil per hour through ¼-in. top choke at the rate of 55 bbl per day through open tubing. Completion was from the Brumfield sand, perforated at 5178-84 and 5186-90 ft.

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WICHITA FALLS, TEXAS

EXPLORATION ACTIVITIES

D'Arcy Drilling Reveals Many Important Minerals

The D'Arcy Exploration Company is planning an early resumption of drilling near Ainsdale-on-Sea, Southport, Lancashire, England, according to its parent company, Anglo Iranian Oil Company. Drilling of a test well stopped at about 4300 ft in December, AIOC reports.

The company's search for oil in the United Kingdom has resulted in the existing oil field at Eakring, Nottinghamshire, and discoveries of other mineral wealth. Deep seams of coal have been proved, and prospects of other coal fields indicated. During drilling at Eskdale, Yorkshire, a large deposit of potash was discovered.

Geophysical Survey Made Of Offshore Areas

Employing a slow burning powder that repeated experiments have shown to be quite harmless to marine life, Western Geophysical Company is now conducting a new seismographic survey of the offshore areas lying between Santa Barbara and Point Concepcion.

The work, which is being done for Standard Oil Company of California, General Petroleum Corporation, and Humble Oil and Refining Company, is a large scale operation requiring the use of 6 vessels and some 30 men. One of the ships is equipped with a jetting spoon for embedding the charge in the ocean floor when recordings are being made in shallow waters.

A Shoran radio permits accurate placing of the vessels and for safety and effectiveness, all efforts are correlated through an extensive radio intercommunications system. Self-orienting seismometers (earth-movement detectors) are being used for the first time on the Pacific Coast.

Core Boring in Gulf Termed Difficult by McClelland

In foundation investigations for offshore drilling structures in the Gulf of Mexico, an increasing number of oil companies insist on exploring each platform site by means of at least one core boring and are basing foundation designs on an interpretation of soil tests on cores from the boring, Bramlette McClelland reported to the Spring convention of the American Society of Civil Engineers in New Orleans, Louisiana.

McClelland, member of Greer and McClelland, consulting engineers, of Houston, Texas, commented:

"Such investigations are difficult and costly. Borings for any major structure must be at least 200 ft and sometimes over 300 ft in depth. Drilling and securing of undisturbed samples from deep borings in open Gulf waters can be accomplished only from a stationary platform.

"Different schemes for erection of coring platforms have been devised. The one used most frequently is in effect a small-scale replica or the oil well platform It consists of a prefabricated jacket made of steel pipe and is supported by four pipe piles driven through the jacket legs. Erection and removal of such a platform requires a large derrick barge, which in turn requires a heavy tug boat. A boat for transportation of the exploration crew must stand by at all times while the work progresses. Thus, costs pyramid rapidly in this as in all other operations offshore.

"The core drilling has been complicated by the known presence of high pressure gas in shallow sands in at least one area."

Montana Oil Show Reported By Cities Service Oil

A slight show of oil at Cities Service Oil Company's McFarland No. 1 wildcat in Yellowstone County, Montana, was reported during coring operations between 5946 and 5966 ft. On a drill-stem test between 5919 and 5966 ft, 520 ft of drilling mud was recovered. The Devonian was topped at 5865 ft, and operators were drilling ahead at 5966 ft.

Union Oil Enters Pact With Brazos Oil and Gas

A. C. Rubel, vice president of the Union Oil Company, and J. P. Bryan, vice president of Brazos Oil and Gas Company, (a wholly-owned subsidiary of Dow Chemical Company) announced the signing of an agreement covering exploration, drilling, and production on their joint lands in the Sacramento Valley. Union is named operator and the term of the agreement is three to four years. Brazos' present production at Isleton is excepted from the operation. The two companies currently have extensive acreage holdings in the Sacramento Valley, and seismic work is being conducted. It is expected that an active program of seismic work, leasing, and drilling will be conducted.

Arkansas Oil Find Reported

McAlester Fuel Company has reported a new oil discovery in Columbia County, Arkansas, at its A-1 Sam J. McCollum. It is flowing 79 bbl of 38.1 gravity oil through 14/64-in. choke from perforations at 5850-58 ft, 5861-64 ft, and 5866-77 ft in the Pettit lime. Total depth of the well is 11,296 ft, plugged back to 5959 ft

Two Possible Oil Basins Seen in Western Europe

The possibility of two large oil-bearing basins in western Europe is being discussed by a symposium of American, German, Danish, and Swedish oil men. Location of one of the possible basins would lie where only isolated oil fields have been known to exist up to the present time. The symposium is studying the new oil strike made by the Danish-American Prospecting Company, in southern Jutland, near Toender. Denmark. Svenska Dagbladet of Stockholm quotes the group of men as saying that the successful Danish Wildcat strike appears to have uncovered not merely an isolated oil field, but an oil basin.

This basin, if it exists, would underly much of northwestern Germany and most of Denmark, indicating a possibility of a manifold extension of the present western German petroleum production—now amounting to 7,840,000 bbl a year. This spring the Swiss will drill two deep test wells at Hoellviken, a German concern, the Duetsche Erdoel A/G, will sink three exploration holes just south of the Jutland border, opposite the Toendern discovery.

The other basin in Western Europe appears to be in the formation that stretches from the Geneva district, on the Franco-Swiss border, to southern Poland, and underlies much of northern Switzerland, Bavaria, and the Wels region of Austria.

Utah Well Flowing

A new well has been reported in Uintah County, Utah, two miles northeast of Roosevelt pool. It is Gulf Oil Company's No. 1 Tynn H. Whitlock, which flowed oil and gas on a test at between 9251-9276 ft in the Green River formation. Oil flow was at a rate of 18 bbl an hour. Except for the No. 1 Ute Tribal, which came in with an initial flow of 1600 bbl a day, this is the only well that has flowed on testing, without swabbing and other completion practices.

Carter Drills Well In Anadarko Basin

A new discovery well has been drilled in the Anadarko Basin, Beaver County, Oklahoma. It is Carter Oil Company's Emby Kaye No. 1, which flowed 128 bbl of clean oil to tanks in three hours, with an estimated 1,000,000 cu ft of gas a day. Producing formation is in a lime zone at 5833-49 ft. The well is southeast of the Light Ranch gas-condensate field. Production in the country was opened earlier in the year by Flynn Oil Company at its No. 1 School Land, with a 130-bbl oil daily pumper.

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Since 1945 UNITED has done all the seismic and gravity meter geophysical work on the 35,000 square miles comprising the Naval Petroleum Reserve No. 4, located on the north slope of the Arctic Coastal Plain. By developing special equipment and using helicopters, weasels and tractors to overcome the obstacles encountered in this rugged, frigid country, UNITED has greatly increased U.S. oil reserves.
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Pan American Opens New Louisiana Field

Pan American Production Company has made a second discovery on its Miami Corporation lands in Cameron and Vermilion Parishes, Louisiana. The new well is Pan American's Miami Corporation "B" No. 1 in what has been designated as the Little Pecan Lake field, about four miles southwest of the previous discovery in the South Pecan Lake field. The well was drilled to a total depth of 13,514 ft and was still in the Miocene sand section, at which point mechanical difficulties precluded deeper drilling, and was plugged back and completed through perforations in the 5½ in. casing from 12,508 to 12,570 ft and 12,460 to 12,496 ft.

On a completion test through ¼-in. choke, the well produced at the rate of 265 bbl of 35.3 deg corrected gravity crude oil per day with 3985 lb pressure on the tubing. The gas oil ratio is 21,500:1.

Pan American's second well in the South Pecan Lake field, Miami Corporation well No. 2, is now in process of completion.

Kentucky Gets Big Gas Well

The biggest gas well to date has been brought in in Kentucky. It is United Fuel Gas Company of Charleston, West Virginia, Pike County producer, credited with production of about 17,000,000 cu ft of gas per day.

Louisiana Gas Well Proves Important Discovery

British-American Oil Producing Company in conjunction with Stanolind Oil and Gas and Kerr-McGee Oil Company have found an important gas-distillate discovery in Cameron Parish, Louisiana. The well, which was drilled to a total depth of 9428 ft after having 7-in. casing cemented, was tested from a 10-ft interval (9356-9366 ft).

Through a ¼-in. bottom hole choke, gas reached the surface in six minutes, after flowing a 4000-ft water cushion. The well produced through surface chokes varying from ⅛ to 14/64-in. at rates between one and 4,000,000 cu ft of gas per day with distillate produced with the gas up to 77 bbl per day.

Union Producing Drills Large Mississippi Well

Union Producing Company has completed what has been termed the most important strike in Mississippi in recent years. It is the company's No. 1 J. T. Sanders, which is the discovery well to the Muldon field of Monroe County, Mississippi. Open flow potential has been calculated at 35,000,000 cu ft of gas per day with a gas-condensate ratio of 100,000 to one. On earlier tests, the well flowed through 7/16-in. choke at the rate of 7,400,000 cu ft of gas per day. Flowing tubing pressure was 1720 lb, and casing pressure 1855 lb. Condensate gravity was 66.2 deg.

Rogers Forms New Geophysical Company

Rogers Geophysical Company has recently been formed by Sam Rogers. Rogers, one of the pioneers in the geophysical field, was formerly associated with Rogers-Ray, Inc., which was dissolved in 1951. Offices of the new company are situated at 3616 West Alabama, Houston.

A new $75,000 laboratory building is now under construction adjoining the office building. The company has a number of crews operating in both foreign and domestic fields. A number of the crew members were employees of Rogers-Ray and have worked with Rogers for 15 years.

Aerial Survey Underway Of Louisiana, ASCE Told

Already one of the country's best-mapped states, Louisiana is under a thorough aerial photography survey with possible defense maneuvers in mind, Gerald FitzGerald, chief topographic engineer, U.S. Geological Survey, told the Spring convention of the American Society of Civil Engineers in New Orleans recently.

"Last year, Dr. Richard J. Russell, Professor of Geography and Dean of the Graduate School at Louisiana State University, undertook a research project for the Department of Defense involving detailed geomorphological investigations of the entire coastal marsh region of Louisiana," said the speaker.

"The Office of Naval Research is providing aerial photographs to cover the area from two different flight heights. The chief reason for the study is to determine possibilities of military maneuvers in swampy country and the chances of success an invading force might have in this type of country.

"The project includes about 12,000 square miles. Most of the research work will be done by students of the University. Field work already is in progress. The Geological Survey is cooperating by mapping the area to be studied which, since it lies wholly in the defense zone, can be given a high priority."

FitzGerald said the U. S. Coast and Geodetic Survey is mapping several areas in southern Louisiana in connection with preparation of hydrographic charts. The projects include East Cote Blanche Bay-White Lake; Houma-Vermillion Bay; Mississippi Sound, which covers the islands east of St. Bernard Parish, and Houma-Port Arthur.

Assam Oil Carries Out Oil Search in India

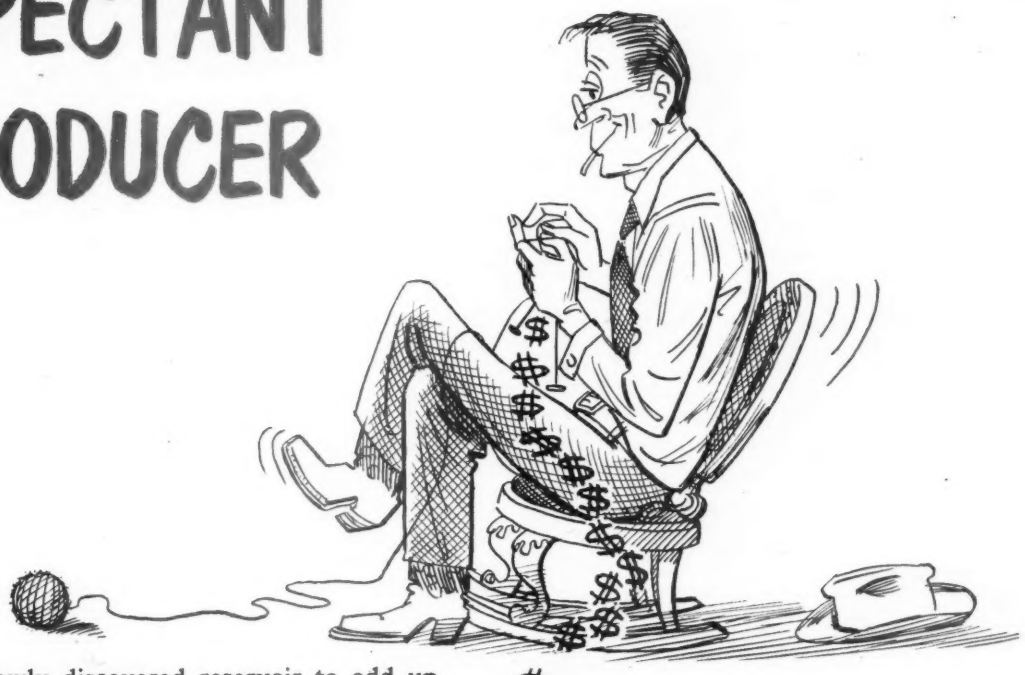
A survey of the oil situation in India reveals that the Assam Oil Company, a subsidiary of Burmah Oil Company, is the only producer of oil in the country. Exploratory drilling is in the more promising areas to the east of the latest Digboi proved wildcat. The unsuccessful well at Barsilla was abandoned at 7200 ft. Meanwhile arrangements are being made to carry out explorations at Nichiguard in the Naga Hills.

Standard-Vacuum Oil has been carrying out aero-magnetic surveys over Gangetic alluvium in Bengal and Assam in order to study the subsurface configuration and investigate the possibility of finding oil.

Illinois Wildcat Produces 154 Bbl of Oil Per Day

Continental Oil Company has completed a wildcat well in Jasper County, Illinois at its No. 1 G. E. McCoy. The well is about two miles from other wells, and is producing 154 bbl of oil a day. About five miles northwest of Oblong, the new well is flowing from the Rosiclare limestone at 1844 to 1850 ft after being acidized.

THE CASE OF THE EXPECTANT PRODUCER



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PETROLEUM RESERVOIR ENGINEERING

Stanolind Brings in New Nebraska Gas Discovery

Stanolind Oil and Gas Company has a new discovery in Banner County, Nebraska, at its Barrett No. 1. On a drillstem test, gas reached the surface in 25 min, with estimated blow of 800,000 cu ft of gas a day. Also recovered were 112 ft of oil and 550 ft of gas cut mud. Upper Muddy has been topped at 6321 ft in the new well.

D'Arcy Carries on Sicilian Oil Search

The D'Arcy Exploration Company, Anglo Iranian Oil Company subsidiary, is increasing its search for oil in Sicily, where it is at work with a gravity meter survey team. The company has about 350 sq miles under license in southern and eastern Sicily, and detailed survey work will continue aided by the most modern scientific processes in an attempt to determine whether and where a deep test well should be drilled.

Papuan Well at 10,000 Ft

A 6⅝-in. casing has been successfully landed in the Anglo Iranian Oil Company's No. 2 well in Horo South Papua, according to an AIOC report. Landing of the casing has been accomplished under difficult circumstances, chief among them being squeezing by the strata formations and loss of mud circulation. The well has been drilled to 10,000 ft in 10 months. H. L. J. Hunter is general fields manager in charge of the drilling of the well. Exploration in Papua is being carried on by the Australasian Petroleum Company, in which Anglo-Iranian has about 40 per cent interest.

Gulf Oil Will Deepen Oil Test to 14,000 Ft

Gulf Oil Company has contracted with the Western Drilling Company of Longview, Texas, to deepen a deep oil test abandoned five years ago. The well, situated in Presidio County, Texas, was initially drilled by Argo Oil Company and abandoned in January 1947. The test was sunk to 10,000 ft, and Gulf will drill on to 14,000 ft.

Louisiana Discovery Made

The Texas Company has reported a new natural gas and condensate discovery near Hermitage Lake area of Plaquemines Parish, Louisiana. It is the company's No. 3 Bradish Johnson, which has been drilled to 13,075 ft. Casing has been set at 12,075 ft, and on initial gage on a ⅛-in. choke 1,528,000 ft of gas were recovered and a small amount of distillate.

Buttram Well Success

A new oil field has been opened west of the Blackdog area in southern Osage County, Oklahoma, at Frank Buttram, independent oil operator's well. The wildcat flowed 54 bbl of oil in one hour from the Skinner sand at 2425 ft. It has been shut in for erection of tanks.

Shallow Test Set for Osage County, Kansas

Cities Service Oil Company (Delaware) has a shallow test in Osage County, Kansas, 20 miles south and six miles east of Topeka. This 2200-ft wildcat is Dilworth No. 1. Main objectives are the Lansing-Kansas City, Mississippian, Hunton and Viola limestones, Simpson sandstone, and Arbuckle Dolomite.

Oklahoma Well Completed

Fordee Rhoades Oil Company has completed its No. 1 Adams in Pottawatomie County, Oklahoma, for a flow of 17 bbl an hour through a 31/64-in. choke from open hole between 4274-86 ft in the Calvin sand. It flowed 7 bbl of oil an hour through a ¼-in. choke and 5 bbl an hour through a 13/64-in. choke.

Carter Gets Wyoming Well

Indications of a new oil pool have been found in Natrona County, Wyoming, at the Carter Oil Company's No. 1 State Burke. The well is situated between Casper and the Salt Creek development, and on drillstem test between 8373-84 ft, recovery was 500 ft of fluid. Three hundred feet of this fluid was 31.3 gravity oil and 200 ft of mud. It is coring at 8486 ft.

Oklahoma Well Flowing

Anderson-Prichard Oil Corporation's No. 1 Fant in Cleveland County, Oklahoma, has been drilled to a total depth of 8001 ft, and is flowing at a rate of 336 bbl of oil in 24 hr. Flow pressure is 100 lb.

Kansas Oil Field Opened

The Texas Company has completed its No. 1 Bryant in Cowley County, Kansas, three miles west of Arkansas City. The well made 80 bbl daily in a flowing test from 3383-88 ft in the Bartlesville sand, which was topped at 3352 ft. The new area has not yet been named.

New Utah Well Successful

Deep Well Production Company of California, has a new oil discovery in the Tertiary producing area of the Uintah Basin of northeastern Utah. It is the company's No. 1 Lambert, 20 miles east of the Duchesne, Utah, pool, which also produces from Green River formation. Test was made between 6265-6314 ft, and gas was at the surface in 10 min, at an estimated rate of 50,000 cu ft to 100,000 cu ft daily. With the gas was a recovery of 590 ft of 44 gravity oil and 10 ft of oil cut mud in 1 hr.

West Virginia Gas Well

United Fuel Gas Company has reported a good gas well in Mingo County, West Virginia. The well is the company's No. 6834 Henry Closterman, which made 1,205,000 cu ft of gas. Total depth of the well is 1843 ft.

Robinson Well Opens New Louisiana Pool

L. L. Robinson's No. 1 Kilpatrick has opened a new field in north Louisiana, Webster Parish. Although no official state test has been taken, the discovery well for the area has been assured successful completion by the fact that the well flowed 8 bbl of fluid hourly for a week before squeezing operations were begun to cement off water sands around the casing. Flow on the test was reported to be 84 per cent oil, gravity 39.6 deg. Final tubing pressure was listed at 110 lb and output is flowing through a 12/64-in. choke. Name of the new field is the Springhill field, after the nearby town of Springhill.

Louisiana Gas Field Seen

A new gas field for Terrebonne Parish, Louisiana, is probable at the Cities Service-Forest Delta No. 1 wildcat, where 150 ft of gas pay is indicated by cores and electric logs. The Miocene test is situated on a 1700-acre block owned by Forest Oil Corporation and Cities Service. Nearest production to the test is the Lake Long field, four miles to the southeast. The Houma pool is 5 miles west of the wildcat. Cores and electric logs to 12,513 ft indicated approximately 150 net feet of gas pay. Operators are coring ahead below 12,513 ft in the Miocene sandstone and shale. Operators indicate the well will be taken down to a total depth of 13,000 ft.

Shell Makes New Discovery In New Mexico County

A new discovery in Lea County, New Mexico, has been completed by Sheli Oil Company at its No. 1 Chesher, Wichita-Albany. The well was completed for a daily flowing potential of 144 bbl of 40.8 gravity oil, with gas-oil ratio of 699-1. Flow is through a 24/64-in. tubing choke, and open hole between 6914-7516 ft. The section was treated with 7900 gal of acid.

Canadian Gas Find Made

Canadian Delhi Oil Company, Ltd., and Britalta Petroleum, Ltd., have made a new gas discovery in Alberta, Canada. It is their Winchell Coulee No. 1, which showed gas in 2½ min, and built up to 3,000,000 cu ft daily from 5236 to 5246 ft. At the end of the 45-min test the gas flow was still increasing. Throughout the test there was a steady spray of distillate grading or light oil. Recovery was 130 ft of distillate grading between 50 and 60 deg API.

Cities Service Stakes Test

Cities Service Oil Company (Delaware) is staking a 5800-ft Ellenburger test in Haskell County, Texas, held by Cities Service and Sinclair. The wildcat is Swenson 15 No. 1, seven miles northeast of the Chapman pool, nearest commercial production. The well will test the Canyon, Strawn, Caddo, Mississippian, and Ellenburger.

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B. R. Scharbarum, Midland, Texas, Carl B. King Drilling Company, was elected district chairman, Southwestern district, American Petroleum Institute's Division of Production.

Vice-chairman elected were: **J. W. Roche,** Wichita Falls, Shell Oil for North Texas; **R. B. Chesney,** Benton, Louisiana, Sunray Oil, Arkansas and North Louisiana; **J. A. Williams, Jr.,** Gladewater, The Texas Company, East Texas; **S. C. Oliphant,** Houston, Stanolind Oil and Gas, Texas Gulf Coast; **Louis Davis,** Dallas, Atlantic Refining, Central Texas; **W. W. Ramseur,** Laurel, Mississippi, Gulf Refining, Alabama-Mississippi; **Roual Dunn,** Hobbs, New Mexico, Phillips Petroleum, New Mexico; **Roy E. Carter,** Kermit, Carter Foundation Production, West Texas; **E. N. Van Duzee,** New Orleans, Shell Oil, South Louisiana; **J. B. Jones,** San Antonio, Halliburton Oil Well Cementing, Southwest Texas; **Ray Elner,** Fort Worth, Kobe, Inc., secretary-treasurer; and **Olin G. Bell,** Houston, Humble Oil and Refining, chairman of the advisory committee.

William L. Horner, petroleum engineer for Sunray Oil Corporation, will be manager of a new department to be established by the company for the control of reservoir engineering and repressuring operations.

Horner will direct the department from the company's general offices in Tulsa, Oklahoma, drawing from the company's present engineering staff for the nucleus of the department. The new department will work in close collaboration with both the production and natural gas sections of the company, but will assume responsibility for instigating and controlling reservoir engineering.

Horner has been with the company since 1943. Currently he is chairman of the engineering committee of the Scurry Area Canyon Reef Operating Committee now in the process of setting up a unitization agreement for fluid injection repressuring in the Kelley-Snyder and adjacent fields in Scurry County, Texas.

S. M. Vauclain, Sun Oil Company geologist, has been transferred from Jackson, Mississippi, to the Philadelphia office. **Emil Monsour,** San Antonio, Texas, replaces Vauclain, and **J. R. Moyer,** Dallas, replaces Monsour.

D. H. Cardwell, San Angelo, Texas, and **George R. Washburn,** Roswell, New Mexico, move to the Dallas office.

Walter L. Erwin, Truth or Consequences, New Mexico, moves to Abilene, Texas, and James J. Tucker, Corpus Christi, Texas, goes to Dallas.

Forrest W. Bell, Delhi, Louisiana, is transferred to Shreveport, Louisiana.

Raymond Siever, associate geologist in the coal division of the Illinois State Geological Survey, Urbana, is the winner of the 1952 President's Award of the American Association of Petroleum Geologists, as announced today by Frank A. Morgan, Richfield Oil Corporation, president of the Association. The award is made annually to the author, under 35 years of age, of the "most significant original contribution to petroleum geology" published in the monthly Bulletin of the Association during the previous year. Selected by a national medal award committee headed by former A.A.P.G. president, Carroll E. Dobbin, U. S. Geological Survey, Denver, Colorado, the winning paper is entitled "The Mississippian—Pennsylvanian Unconformity in Illinois," and appeared in the March, 1951, issue of the A.A.P.G. Bulletin. Presentation of the award, which includes $100 in cash, was made at the 37th annual meeting of A.A.P.G. last month.

Siever received the B.S. degree in 1943 at the University of Chicago. The following year he worked as a research assistant with the Illinois State Geological Survey.

G. T. Alexander, who joined The Texas Company at Shreveport, Louisiana, 32 years ago, has been promoted to assistant to division manager of Louisiana division, Texaco's producing department. A native of Greenwood, Louisiana, Alexander will be succeeded as division land and leaseman, effective the same date, by **G. A. Gammill,** who has been assistant division land and leaseman since 1939.

Joining the company as leaseman at Shreveport, in 1919, Alexander became division land and leaseman in 1929. He was transferred to New Orleans in 1941, when the division offices were moved from Shreveport.

Gammill was employed by The Texas Company as a leaseman in 1928 at Shreveport. He was made assistant division land and leaseman at Lafayette in 1939 and was moved to New Orleans in the same position in 1941.

Henry N. Toler, chief geologist and manager of the production department of Southern Natural Gas Company, has resigned his position and will open offices as a consulting geologist in Jackson, Mississippi, where he has been stationed for many years.

He has been very active in affairs of the American Association of Petroleum Geologists, having served as secretary-treasurer and a member of the executive committee of that organization during 1949 and 1950. Toler has had many years experience in geological work in the Gulf Coastal area as well as other sections of the country.

H. A. Sellin, geological department, Magnolia Petroleum Company, has been promoted to regional exploration geologist and transferred to Magnolia's general offices in Dallas. He replaces **C. Ivan Alexander,** who has been made supervisor of the exploration research division at the company's field research laboratories, Dallas. **W. Lloyd Haseltine** has been transferred from district geologist at Wichita Falls, Texas, to the same position in Mt. Vernon, Illinois. **John C. Freeman** has been promoted to district geologist at Wichita Falls.

O. F. Beaty has been transferred from land man at Amarillo to Mt. Vernon. **Fred A. Dulaney, Jr.,** succeeds Beaty as district land man in the Amarillo district. **Basil Moss** has been transferred to New Orleans, Louisiana, where a new land department district has been opened.

Lawrence M. Green, who has been assistant foreman in Magnolia's Falfurrias producing district, has been promoted to production foreman in the company's Vanderbilt district. **Charles A. Miller,** petroleum engineering assistant in the Kermit district, has been promoted to assistant foreman in Magnolia's newly created Pegasus district near Midland, Texas. **Marion W. Lovelace,** production pumper in the Brownfield district, has been promoted to assistant foreman in the Pegasus district. **Don B. Chism,** gang pusher in the Lake Charles producing district, has been made assistant foreman in the same district.

James L. Cowell has been named stratigrapher in the Ventura, California, area for Shell Oil Company. He was formerly senior geologist there. Other promotions in the exploration department in this area include: **J. D. Bloomingdale,** geologist, transferred to Butte, Montana, from Midland, Texas; **E. M. Curry,** promoted to division geophysicist at Ventura, from coastal seismologist, and **R. O. LaRue,** seismologist, transferred from Long Beach to Casper, Wyoming.

Parker A. Robertson was recently appointed assistant division exploration adviser for Gulf Oil Corporation at Houston, Texas. He replaces **Elliott H. Powers,** who resigned to join Southern Production Company as vice president in charge of exploration. Robertson will continue as division reserves adviser to the vice president.

Ben F. Baldwin, formerly district geologist for Stanolind Oil and Gas Company in Jackson, Mississippi, is being transferred to Albuquerque, New Mexico, where he will head a new district office. He is succeeded at Jackson by **Charles A. Houston.**

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SERVICE LOCATIONS: TEXAS: Houston, Snyder, Alice, Cisco, Corpus Christi, McAllen, Odessa, Tyler, San Angelo, Victoria, Wichita Falls. **OKLAHOMA:** Oklahoma City, Guymon, Healdton. **MISSISSIPPI:** Laurel. **NEW MEXICO:** Hobbs. **KANSAS:** Great Bend. **WYOMING:** Casper. **CALIFORNIA:** Los Angeles, Avenal, Bakersfield, Ventura. **LOUISIANA:** Houma, Lake Charles, New Iberia, Shreveport. **COLORADO:** Sterling.

To obtain more information on products advertised see page E-51

▸ **J. C. Brooks** has been promoted assistant to general manager of The Texas Company's producing department. Succeeding Brooks as department agent, accounting division of the producing department, will be **E. M. Jacobs,** now assistant department agent.

Louis W. Anderson, departmental chief accountant, stepped up to assistant departmental agent. **Alfred R. Kroulik,** assistant to departmental agent, has been named departmental chief accountant.

Brooks attended Rice Institute. He was employed by The Texas Company in 1921, as a bookkeeper in the comptroller's department at Houston.

After serving as chief accountant for almost five years, he became assistant department agent in 1943 and was appointed department agent.

Jacobs studied two years at Louisiana State University and later took special courses at the University of Southern California. He joined the company in 1920. Anderson joined with the company in 1930, after his graduation from Texas A. & M. College with the BS degree. Upon his graduation from Texas A. & M. with the BS degree, Kroulik was employed by Texaco as a clerk at Houston in 1929.

▸ **J. E. Washam,** drilling superintendent, Ruhl Drilling Company, Inc., has been transferred to the company's field headquarters at Alice, Texas. He was formerly at Rockport, Texas.

▸ **T. F. Harriss, John W. LeSassier,** and **John E. Turner** are now associated with Lloyd, Penn, and Hills, consulting geologists and petroleum engineers. Offices are situated at 21 Permian Building, in Midland, Texas.

▸ **Joseph Neely** has been transferred from Tyler, Texas, where he was district geologist in charge of the East Texas district, to Midland, Texas, where he is district geologist for Magnolia Petroleum Company's West Texas district. Neely replaces **H. A. Hemphill,** who has resigned from the company.

Wayne R. Hammond has been transferred from Magnolia's general offices in Dallas, to Tyler, Texas, where he is district geologist in charge of the East Texas district.

W. Lloyd Haseltine has been moved to Dallas as regional geologist in charge of the development section. Haseltine has been district geologist at Mt. Vernon, Illinois.

A new geological district has been formed with headquarters at Bismarck, North Dakota. This district, which includes the states of North and South Dakota, will be in charge of **P. R. Tetrick** who has been promoted to district geologist.

J. Edgar Middleton has been transferred from the petroleum engineering department of Magnolia's Falfurrias producing district to the Pegasus district in West Texas where he is serving as assistant production foreman.

▸ **Walter E. Sistrunk** has been elected to fill the unexpired term of office as vice president of the Mississippi Geological Society. He replaces **F. T. Holden** geologist for Carter Oil Company, who was transferred to Tulsa, Oklahoma, recently. Sistrunk was formerly an independent operator in Jackson, Mississippi.

▸ **Edward J. Boos** has resigned his position as district head of exploration for Sohio Petroleum Company at Casper, Wyoming, and has joined Emmett E. Schieck, consulting geologist. Schieck, who has offices in Casper, was formerly chief geologist with Morton Oil Company, until about a year ago when he became a consultant.

▸ **James R. Willcockson** was recently named field seismograph supervisor in the central-division office of Stanolind Oil and Gas Company at Oklahoma City. He joined the company in 1947.

▸ **Robert W. Frensley** has become a partner in the geological firm Landrum and Frensley, with headquarters at Ardmore, Oklahoma. Frensley was previously a geologist with Continental Oil Company, Wichita, Kansas.

▸ **E. S. Marie,** district geologist for American Republics Corporation and Ed Brown, geologist have been transferred from San Antonio to Corpus Christi as a result of the firm's office move.

Venezuela is subject of speech before Houston Chapter Nomads at March Meeting.

W. J. Gillingham, below, executive vice president, Schlumberger Well Surveying Corporation of Houston, was guest speaker at Houston Nomads meeting. He spoke on Venezuela in particular and South America in general in the oil picture.

Special guests, above are: R. de Panafieu, SNPA, Paris; Norman C. Brown, Sted Brothers, London; James L. Wall, Jr., Texaco, Caracas; L. A. Allaud, Schlumberger, Venezuela. Also present were J. de la Garza, drilling contractor, Mexico City, Mont Land, Petrolite, Venezuela.

Charles P. Duncan, Jr., is now chief geologist of The Manufacturers Light and Heat Company and associated Pittsburgh Group gas companies in the Columbia Gas System.

In making known this promotion, John C. Peterson, vice president and general manager said Duncan succeeded Frank A. Boyd who is now in business in Pittsburgh as a geologist and petroleum engineer.

Duncan was graduated by the University of Pittsburgh with a bachelor of science degree in geology. He joined the gas company as a geologist in 1949. For the last eight months he has been serving as assistant chief geologist.

Boyd entered gas company employment in 1940 as an engineer in the gas production department. He was named chief geologist in March 1948.

Don Anderson of Bartlesville, superintendent of production in the natural gas division of Cities Service Oil (Delaware), has been transferred to the company's Calgary, Canada, staff, where he will superintend drilling and production operations in the Canadian plains area. Anderson joined Cities Service's engineering department after attending Purdue University and graduating from the University of Iowa in 1930 with a degree in mechanical engineering.

Ray Thompson recently joined British American Oil Company, Ltd., as Hiawatha Oil and Gas Company's division exploration manager, and will be in

Charles P. Duncan, Jr.

charge of the firm's newly created office at Denver, Colorado. **C. L. Severy,** will be the new division geologist in the new office. He was previously with The California Company.

S. G. Dolan recently joined the geological department of Honolulu Oil Corporation at Santa Barbara, California. Prior to this move he had been with the California Division of Oil and Gas for the last 25 years, stationed at Los Angeles, Santa Barbara, and Santa Maria.

Foster Morrell has opened offices at Roswell, New Mexico, as a petroleum consultant specializing in work on Federal and Indian lands. He has resigned after 25 years on the U. S. Geological Survey. He has been regional oil and gas supervisor for the southwestern region of the conservation division since 1945.

Dr. J. P. Minton of the Field Research Laboratories, Magnolia Petroleum Company, Dallas, Texas, has been granted a special leave of absence. Dr. Minton has been with Magnolia for the past 16 years, serving as director of geophysical research, associate director in charge of physical and exploration research, and for the past five years as research advisor. He will continue to serve the laboratories on a part time basis, but will make his residence in San Antonio, Texas, with his son, M. C. Minton, district geologist for Great Lakes Carbon Corporation in San Antonio.

W. A. (Bill) Wilson, Web Wilson Oil Tools, Inc., has been elected president of the Los Angeles chapter of NOMADS succeeding **Earl Rees,** who has been transferred to New York as Byron Jackson export manager.

Wallace Sawdon has been named executive secretary of the chapter to succeed **John Rife** who has resigned because of press of other business.

William O. Callaway, formerly with The Chicago Corporation has been made district exploration manager for British American Oil Company at Fort Worth, Texas.

Charles D. McMurray has joined the geological staff of Claude B. Hammill, Houston, Texas, independent operator. McMurray was formerly geologist for Gulf Oil Corporation at Houston.

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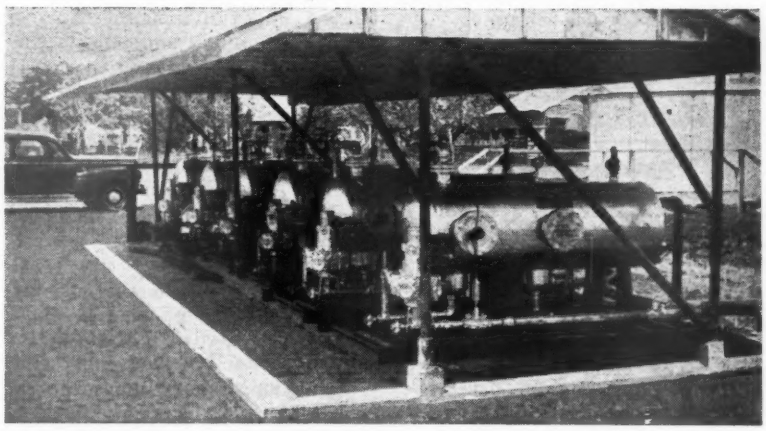

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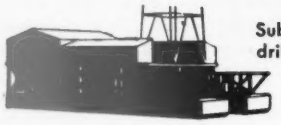

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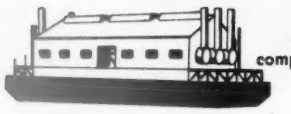
Tugs



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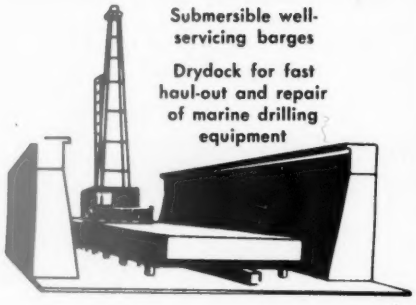

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Orange, Texas

▸ **W. T. Kennedy,** formerly assistant to the general superintendent of production at Findlay, Ohio, for the Ohio Oil Company has been appointed assistant division superintendent in the Los Angeles division at Bakersfield, California.

R. E. McMillen, Houston, Texas, division petroleum engineer has been named assistant to the general superintendent of production, succeeding Kennedy.

L. H. Shearer, petroleum engineer in the Houston division, has been promoted to Houston division petroleum engineer.

J. H. Shonk, formerly assistant district superintendent at Robinson, Illinois, has been appointed special assistant to the division superintendent of the Terre Haute division.

A. W. Stewart has been named supervisor of personnel in the Terre Haute division. He was formerly supervisor of personnel in the Shreveport division.

L. W. Pelton, landman at Shreveport, has been appointed supervisor of personnel in the Shreveport division, succeeding Stewart.

▸ **Herbert A. Hemphill,** widely known geologist in West Texas has been appointed president of Texas Eastern Production Corporation, wholly owned subsidiary of Texas Eastern Transmission Corporation. Hemphill has resigned from Magnolia Petroleum Company at Midland to accept this new post.

Hemphill majored in geology at the University of Texas, where he also served as geological assistant to Dr. E. H. Sellards, then director of the Bureau of Economic Geology. In 1930 Hemphill was employed as a sub-surface geologist for University Lands in West Texas. After four and one-half years he joined Magnolia as an assistant geologist at Midland, later becoming district geologist there.

R. H. Hargrove, president of Texas Eastern Transmission Corporation, whom Hemphill succeeds to the presidency of Texas Eastern Production Corporation, requested the board of that company to accept his resignation in order that he might devote his time fully to the administration of the parent company, Texas Eastern Transmission Corporation, of which he remains president and a director.

▸ **N. L. Falcon,** member of the Anglo Iranian Oil Company's head office staff, has been awarded the Murchison Fund by the Council of the Geological Society of London. Falcon joined the company in 1927, and during the next 9 years took part in many exploration surveys in the mountain belt of Southern Iran and in Iranian Baluchistan.

Falcon has been engaged in oil exploration in the United Kingdom. Last year in cooperation with L. H. Tarrant of the company's geophysical staff, he presented a paper to the Geological Society on the Gravitational and Magnetic Exploration of South Central England, which received special mention in announcement of the award.

▸ **Dr. L. Y. Faust,** geophysicist with Amerada Petroleum Corporation, Tulsa, Oklahoma, received the fourth annual best paper award of the Society of Exploration Geophysicists before the society's twenty-second annual meeting at Los Angeles. The award consists of a certificate and plaque, and was presented to Dr. Faust as author of "Seismic Velocity as a Function of Depth and Geologic Time", the paper voted by the society's committee on honors and awards to be the most outstanding contribution published in *Geophysics* during the year 1951. Presentation of the award was made by Dr. Sigmund Hammer, Gulf Research and Development Company, Pittsburgh, Pennsylvania, retiring president of the SEG.

Faust received a B.S. degree in physics from Franklin and Marshall College in 1925 and the Ph.D. in physics from the University of Pennsylvania in 1930.

His geophysical experience began with Sun Oil in 1926. Since 1930 he has been employed by the Geophysical Research Corporation and Amerada Petroleum, serving as a seismograph party chief until 1933 and as geophysical supervisor since that time.

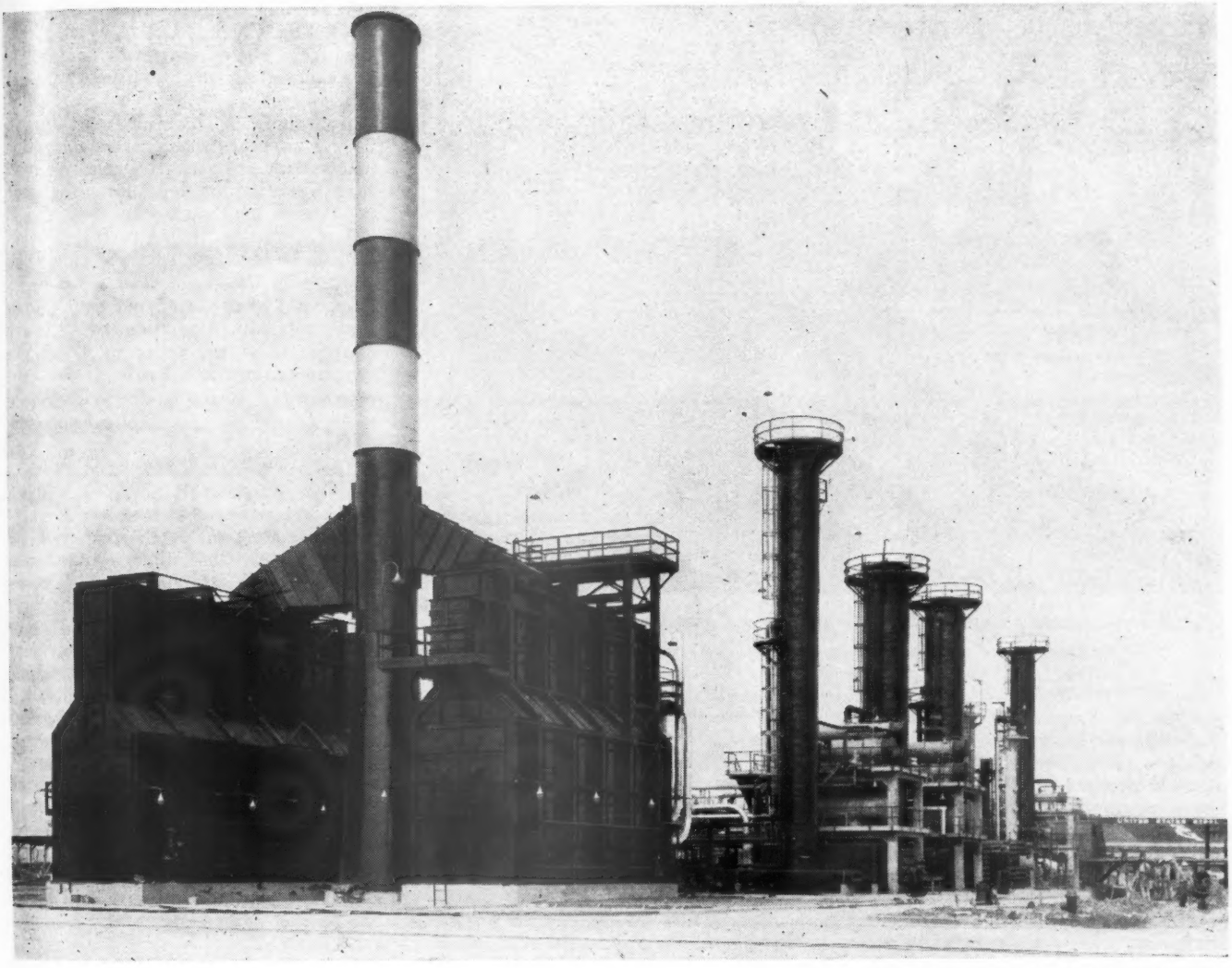
▸ **Dr. E. A. Eckhardt,** vice president of Gulf Research and Development Company, Pittsburgh, Pennsylvania, was awarded honorary membership in the Society of Exploration Geophysicists during its twenty-second annual meeting at the Biltmore Hotel in Los Angeles, last month. The citation was given by Dr. Sigmund Hammer, also of Gulf Research and Development Company, retiring president of SEG.

Eckhardt was trained in physics at the University of Pennsylvania, receiving the degrees of BS in 1908 and PhD in 1912. Late in 1924 he was employed by the Marland Oil Company to organize one of the first oil company geophysical departments. Late in 1928 he accepted a similar appointment with the Gulf Oil. From 1929 to 1946 he was in charge of the geophysical division of the Gulf Research and Development Company, and since 1942, has been a vice president of that organization.

Dr. Eckhardt is a past president of the Society of Exploration Geophysicists, and he has served since 1947 as chairman of its committee on geophysical activity. He is a member of the AAPG and numerous other societies.

▸ **Clark F. Barb,** head of the petroleum-engineering department at the Colorado School of Mines, has been named chairman of the Colorado State Secondary Recovery committee of the Interstate Oil Compact commission.

Announcement of the appointment was made by Judge Warwick W. Downing, official representative of the Interstate Oil Compact commission from Colorado. Barb, who was also recently appointed to the research and coordinating committee of the commission, will attend the spring meeting of the group in Phoenix May 9-10.



Eastern States Petroleum Company's UOP Platforming unit.

MORE CATALYSIS—Refining's Watchword

Exacting control of product yields and qualities have been made practicable by new design principles, greatly improved catalysts

ARCH L. FOSTER*

"ACCELERATED" is probably the best expression to describe, in one word, the rate of progress in refining processing, and the innumerable correlating items that go collectively to make up the technology of the refining industry. Nowadays two principles appear to rule the ever-widening field of revision of refining processes; the first, that of improvement of the qualities of products, or more of the better materials, of lower losses to refining; the second, that of larger yields from crude to help to relieve the "threatened" shortage for the country and the world.

Recently a well known leader in refining technology stated that the trend of present day refining appears to be in the direction of a single general type of unit, with a multiplicity of catalysts. This combination, by changes in charge stock, in operating details and in catalyst would be able to make almost any product desired, largely by breaking down the naturally occurring stock into relatively simple components, which then react to form the product sought. Doubtless this view is somewhat exaggerated, simplifying the situation overmuch, but certainly the outstanding trend is in the direction implied by this notion.

It is trite to say that the refining industry is adopting and adapting catalysis to its ends, with results that make previous accomplishments seem some-

*Editor, Refining and Gas Processing.

EXCLUSIVE

Control and instrument panel for fuel research, Ethyl Corporation.

what trivial. Early in World War II a famous research director in the coal tar industry railed at the petroleum industry's promise that it would make large amounts of war-needed benzene and it homologues, pointing out that at that date "not a barrel of petroleum toluene has been made, commercially". Yet by the end of that War the major portion of our supplies of aromatics was originating from petroleum, and mostly via the catalyst (Hydroforming) route.

To minimize those very creditable accomplishments, the processes developed within the period since war's end now convert commercially in dozens of units the most non-aromatic of stocks, highly paraffinic naphthas, to high octane rating fuels, as high as 60 per cent or even more of benzene, toluene, the xylenes, and other homologues. More than one type of catalyst is available for doing this, with an efficiency undreamed of a decade back.

Without doubt the most outstanding progress made during the last year or two has been in the realm of catalytic reforming of low-grade naphthas. This progress, combined with the advances in catalytic cracking of heavier stocks, has made the refiner practically independent in the problem of supplying his customers with the grade and octane rating of motor fuel, within the limits of any commercial demand that can be foreseen within the next ten years or so. Aviation fuel is demanding more and more aromatics to boost high-output efficiency of its reciprocating engines. The aromatic content is and will be made directly in the fuel components via catalytic cracking and catalytic "treating" (the latter actually a type of catalytic reforming of cat-cracked naphthas). This aromatic content is augmented by concentration of catalytic reformate aromatics by such processes as the Udex, the Arosorb, and others using solvents, adsorbents, etc., to separate benzene-toluene from paraffinic, isoparaffinic, and naphthenic constituents that are suitable for automotive engine and similar fuels. Eastern States Petroleum Company has just put on stream a combination of a Platformer catalytic reformer unit and a Udex solvent concentration unit for the specific purpose of producing large amounts of aromatics to meet the critical demands of the Armed Forces and other consumers. This unit employs four "passes" through catalyst beds instead of the heretofore customary three, to further this purpose. Many other reforming units, built on Houdriforming, fluid Hydroforming, Socony-Vacuum's catalytic reforming, and Atlantic's new process for the same purpose, as well as the oldest process, Platforming, are operating or building, including the largest, 15,000 bbl per day at Shell's Houston plant to make better motor and aviation fuels.

Two types of catalysts are in use for these purposes; the Platformer catalyst, platinum-carrying, which has a very high efficiency for the job and on which so little carbon is deposited that regeneration is not considered economic or necessary, especially as a routine continuous operation, for most operations. More recently Socony researchers have discussed catalysts containing chromium oxide and alumina, which are regenerated continuously in the TCR process, similar to the TCC process commercialized in war time and since revised thoroughly. Results announced in March show that when using this catalyst in bead form on a West Texas naphtha the yields of C_4's-plus-heavier reformate range from 91 volume per cent of 88 clear octane number at about 960 F to 88 per cent of 92 clear octane number at 977 F, and 81 per cent of 99 octane number when reformed at 1008 F. (Ind. Eng. Chem. *44*, 572 (1952)). Respectively, these reformates contain 43 per cent, 50 per cent and nearly 60 per cent aromatics.

Reforming a light-medium and a heavy naphtha with chromia-alumina catalyst for aromatics especially shows that from the lighter charge benzene production may vary with stocks from different crudes from 4 to 10 per cent, toluene 15 to 21 per cent and C_8's (xylenes, etc.) 5 to 8 per cent, for a maximum total of about 40 per cent. Maximum total of aromatics from heavy naphtha is of the order of 45-50 per cent, including C_9's. Up to 97 per cent of the sulfur in the stocks is converted to H_2S and is thus removable by caustic washing.

The one principle in catalytic cracking that appears to be fixed without peradventure of doubt is that of a transferred catalyst mass. Earlier fixed-bed cat processes that demonstrated the superiority of catalytic cracking have passed from practice, superseded by either the so-called "moving-bed" processes represented by Houdriflow and Thermofor catalytic cracking systems, or the so-called Fluid process, installed widely under that general name. Several considerations dictate this trend, one of the greatest being that of transfer of heat to and from catalyst regenerator and reactor zones. The Houdry pioneer process employs a very complicated, expensive, and time-consuming system whereby catalyst is used to crack charge, collects coke, is purged, coke burned off, purged again, and returned to the cracking phase of the cycle all within a matter of minutes. Problems galore loomed in the matter of maintaining catalyst efficiency, and in reducing the installation and operating costs.

Two different schools of endeavor developed the moving-bed system, itself complicated by expensive mechanical elevation of spent catalyst to the top of the regenerator, and to the reactor, "bucket brigades" that gave some trouble. More recently the Air-Lift system employs air or a gas to lift the catalyst to the top of the regenerator, this placed above the reactor and into which the regenerated catalyst drops by gravity flow. Use of liquid feed to the reactor, and of concurrent catalyst-charge flow has increased the boiling range of stock that can be used. Interestingly enough, Lassiat and collaborators point out that trace amounts of copper and vanadium, especially, in the feed stock are direct catalyst poisons, deactivating the "cat" so that distillate stocks must be charged.

Desulfurization is an important phase of catalytic cracking. Natural clay catalysts, lower in cost than synthetics, are deactivated by sulfur, but it was found that by hydrating the regenerated catalyst before it is brought into contact with charge this problem is solved. Traces of iron in the catalyst forming FeS and, catalyzing large yields of coke and gas, is considered the cause of this deactivation.

Synthetic catalysts show higher yields

of higher octane number product, and so in most cases the problem to solve in deciding which catalyst to use is an economic one; will the higher yield-quality return more than pay for the higher catalyst cost? The endothermic cracking reaction requires addition of heat to the system; this is solved by more rapid circulation of greater quantities of regenerated catalyst, transferring the regeneration heat to the reactor.

"The prospects for improvements in the moving-bed catalytic cracking process appear to be in the direction of improved catalysts that provide increased yields of gasoline for a given yield of coke and have higher regeneration rates and greater chemical and physical stability", (Lassiat et al), is probably the best one-sentence summation of the situation.

What may be termed another system for the transfer of catalysts from reactor to regenerator and back is the fluid catalyst, or fluid solids principle, applied widely in catalytic cracking. In this system a finely divided catalyst is transported about by strong currents of gas or vapors without mechanical aid, and catalyst is concentrated in regenerator and reactor as a fluidized bed through which vapors of charge or regenerating air pass. This principle has been applied to the synthesis of hydrocarbons in the modern applications of the Fischer-Tropsch synthesis such as the Hydrocol unit at Brownsville, and in the Synthol process, to catalytic operations in the chemical field and in fact seems to offer good results in any situation where a catalyst and a fluid charge stock are to be brought into contact.

More recent revisions of this process and principle include its adaptation to much smaller units of 1500 bbl per day capacity and up, making it economic for the small refiner; and the remarkable increase in throughput capacity of old and new units merely by the elimination of bottle-necks, boosting of carbon removal capacity and better heat transfer, to mention a few of the new details. By these methods a wartime 15,000 bbl per day unit's redesign capacity has been raised to as high as 50,000 bbl per day. Overall height of structure has been reduced 30 per cent or more; integration of the fluid unit into the refinery, as in combination distillation - cracking units analogous to the thermal cracking-topping-crude distillation units of prewar development, is one of the directions in which improvements are to come. In this type process also catalyst improvemer are progressing apace.

More recent experimental work has shown the effects of different variables on the results obtained in "cat" cracking. Using a silica-alumina (synthetic) catalyst at reaction temperatures ranging from 850 to 1000 F, and a total conversion of 55 per cent of charge in each case, the "clear" F-1 octane ratings at 50 F intervals of cracking temperature are 93.8, 95.2, 96.5, and 97.5, the highest of which is brought up to 100.5 F-1 by 2 ml. TEL. Of three general types of catalyst, Silica-alumina, natural clay, and silica-magnesia in fluid operation the natural clay "cat" is between the other two in yield-octane rating propensities. Silica-alumina gives the highest octane rating, lowest yield; magnesia-silica the lowest octane rating and highest yield; natural clay shows higher yield and lower octane rating than silica-alumina, lower yield and higher octane rating than the magnesia catalyst. These several values for test operations at 975 F reactor temperature, 60 per cent total conversion, catalyst/oil ratio 6-12, are:

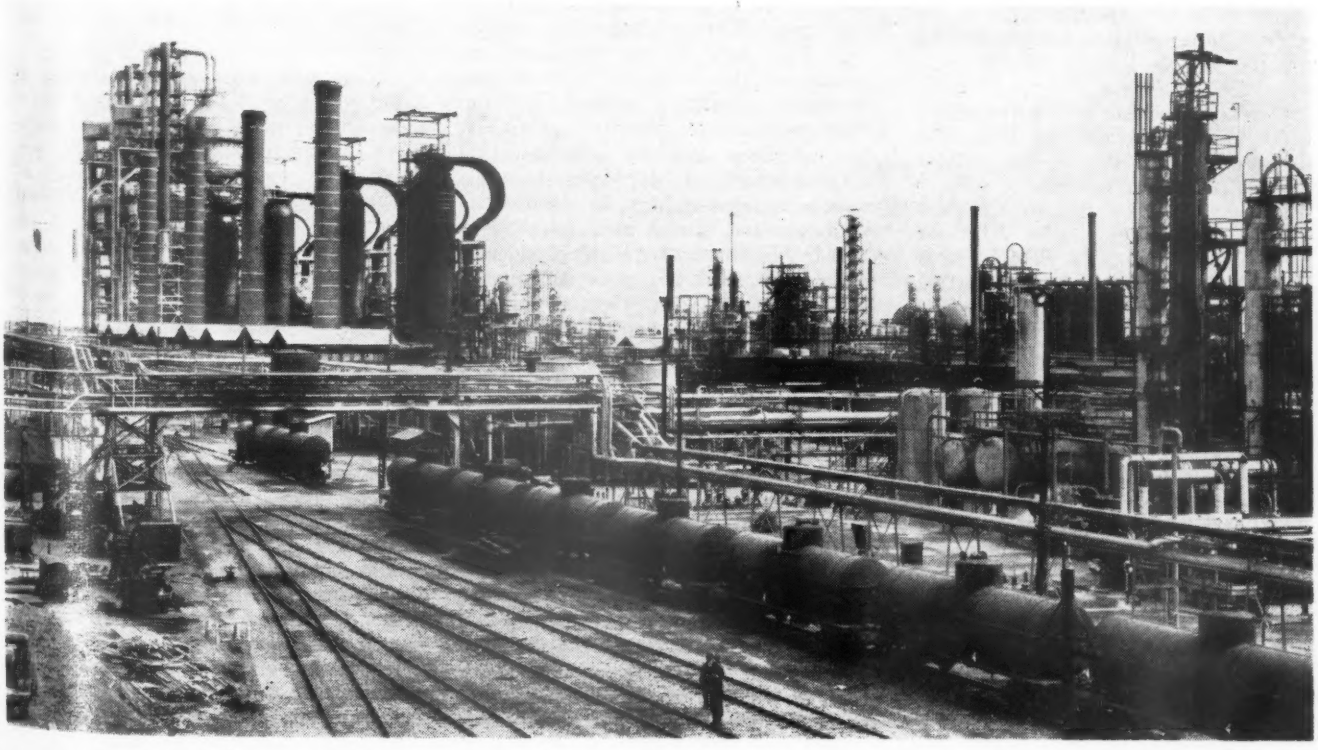
	Silica-Alumina	Natural Clay	Silica-Magnesia
Yield, %	45.5	47.8	56.2
Octane Rating, F-1, clear	95.0	93.6	91.5

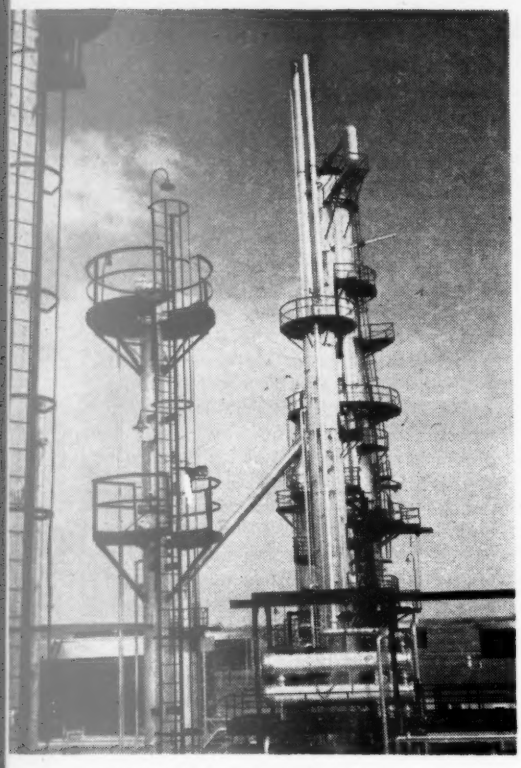
These catalysts showed production yields of butylenes of about 9 per cent, for the first two, 6.4 per cent for the magnesia "cat".

Outstanding also during the immediate past is the rejuvenation of the earlier fixed-bed design of the Hydroforming process, the operation that did such yeoman service in synthesizing aromatics during the late war. Initially a decidedly expensive unit in both installation and operating costs it has been revised using the fluid catalyst principle to give continuous reaction and regeneration in one reactor and one regenerator to make this process competitive, it is claimed, with other naphtha-catalyzing processes. Employing a molybdenum oxide-on-alumina catalyst, it was found that by reducing the sodium content of the alumina carrier from "several tenths of a per cent" to less than 0.1 Na the activity and life of the catalyst has been extended from 3-4 months in service to 9-12 monthes life. The present catalyst contains somewhat less than 10 per cent of molybdena, has better activity (efficiency) and longer life, its base being alumina gel. The recycle gas contains 75 to 85 per cent hydrogen, pressures of the order of 250 psig. Strangely enough, a supported chromia catalyst showed to be better at atmospheric pressures than the molybdena catalyst, but at elevated

Tank cars waiting to be loaded at Baton Rouge refinery, Louisiana.

Standard Oil Company (N. J.) photo.





Midget Fluid cat cracking unit at Panhandle Refining Company, Wichita Falls, Texas.

pressures in a hydrogen atmosphere, the MoO_3-alumina catalyst was much the better. Ninety to ninety-five per cent yields of C_4's-and-heavier are obtained from fixed-bed operations, with CFRR octane ratings of 81.5-86.4, which can be raised to 92-95 with 3 ml. TEL, and more than 40 per cent of total aromatics. The aromatic production can be boosted when running expressly for high aromatics content.

From fluid bed operation 2.0 to 2.5 per cent higher yields are obtained than from the fixed-bed units. At 250 psig, yields of 88 volume per cent of hydroformate are obtained, which are raised to 100 "research octane" by TEL; 500 psig reduces this yield five per cent for the same octane rating range.

The economics reported for the fluid hydroforming process, for a 7500 bbl per day charge capacity yielding 6800 bbl of product show credits of $36,000 against $30,000 cost per day before depreciation, a margin of a little more than $6000 per day, for a payout time of one year.

The Platforming process, commercially the oldest of the postwar reforming routines, has been discussed to a considerable degree in print and its yields and product qualities are well known. More recently overall yields of platformate, up to 95 per cent of charge, amount to more than 40 bbl per lb of catalyst, which though it can be regenerated is not so handled in present commercial processes. "Leaded" research octane numbers range 93 to 94, normally. TEL susceptibility of Platformate from, say, Mid-Continent naphtha, shows to be 2.0 to 2.5 research octane numbers more than that of thermally reformed gasoline.

Investigational studies have shown some interesting results from Platforming. From pure compounds it is found that this catalyst and process tend to split n-heptane for example at the middle carbon-carbon linkage at a rate nearly nine times that of splitting at the terminal C-C bond, yielding hydrocarbons of about half the molecular weight of the charge. Aromatics split off long aliphatic side-chains and scatter shorter side-chains around the nucleus, producing polyalkylated aromatics. Yields of benzene up to 92 per cent of the cyclohexane-methylcyclopentane content of the charge are obtained.

Further research shows that in thermal reforming paraffins are most easily cracked, 62 per cent being converted as compared to 42 per cent conversion of naphthenes; only 2 per cent of the aromatics are changed under the given test conditions. The first 20 per cent of the Platformate product is found to be paraffinic, with about equal parts of paraffins and aromatics, and small amounts of naphthenes, paraffins being reduced in percentage as the boiling point rises while aromatics increase correspondingly. Eighty-five per cent of paraffins in the charge are unchanged; 79 per cent of the naphthenes are changed to aromatics, a small portion are hydrocracked, the rest remains as naphthenes; the product boiling in the top range is essentially all aromatics.

The history of the synthesis of hydrocarbons from coal, natural gas, etc., (Fischer-Tropsch) in postwar U. S. A. is a story of overcoming serious difficulty after difficulty, with remarkable strides being made in several phases of the work. One of these advances is the adoption and improvement of the iron catalyst. Next is the adaptation of the fluid principle to catalyst-vapor contacting. This fluid system eliminated or minimized the Germans' most serious problems, intimate contact between huge volumes of catalyst and CO-H_2 gas mixtures, and the withdrawal of large amounts of heat from the reaction zone. This reduces largely the installation cost of such units.

A third step forward is the production of low-cost, high purity oxygen, a process based on the German Frankl method but made practicable by the reversing heat exchanger developed by Collins of M. I. T. The Hydrocol unit at Brownsville is operating, it is understood; the catalyst (freshly regenerated) is a mixture of iron carbides and iron oxides, with some metallic iron, and may collect as much as 50 weight per cent of carbon deposit without affecting its activity seriously. One huge problem is that of reconversion of oxygenated hydrocarbons to hydrocarbons, to improve yields and reduce the commercial problem of their disposal. A Synthol unit is under design for South Africa, using carbon monoxide and hydrogen from coal.

Costs for the conversion of various materials to motor fuel and other hydrocarbons have been discussed widely, especially by Federal agencies, and strong disagreement exists between them and private industry leaders on many critical points. Discussing coal-to-liquid hydrocarbons, Bureau of Mines estimates claim the cost of gasoline from coal to be 12.1 to 15.6 cents per gal. less the value of liquefied petroleum gases produced. "A three per cent net return on total plant cost increases this cost by 2.0 to 2.5 cents per gal" (Rept. of Invest. 4564). In another report (Rept. Invest. 4651) a unit to hydrogenate 16,500 bbl per day of heavy petroleum residum to make gasoline of 78-82 octane number, is $34,000,000; the final estimate of gasoline cost including three per cent on investment is 17.0 to 20.6 cents per gal. Meanwhile the National Petroleum Council disagrees with Bureau figures, saying with much data to prove the contention that the cost, considering *all* costs that must be included in a private enterprise operation will be nearer 41 cents per gal.

Space is not available to discuss nearly all the newer developments. Among the more recent ones which seems to offer promise may be mentioned such innovations as the manufacture of greases from non-soap gelling agents, as phthalocyanine pigments. These highly colored products yield greases similar to those from soaps in bleeding, texture, and lubricating efficiency. They have lower oxidation tendencies, retain useful grease structures at above 150 C (302 F), are inherently water-repellent, stiffen rather than soften at higher temperatures, and permit formulation at lower consistencies requiring less power (torque) in starting machinery. Researchers believe that the temperature limit for lubricating ball bearings with greases is now the thermal stability of the oils used and the properties of the metals involved.

Some attention has been given in recent years to "Liquid Thermal Diffusion" as a process for continuous separation of liquid mixtures. It has been found that by exposing such mixtures, isomers, for example, to two surfaces set close together, one hot and the other cold, that the long-chain molecules will foregather near the cold wall, and the more compact and complex molecules will assemble near the hot wall, and that each can be withdrawn separately from the other by mechanical arrangements of suitable character. Such columns for these separations range from 5 to 40 ft in height. Experimental work has shown that the best wall spacing, or interval is from 0.02-in. to 0.06-in. Under these conditions paraffin-aromatics mixtures have been separated, the paraffins at the top, the aromatics at the bottom of the space. Tall oil has been separated into saturated fatty acids, unsaturated fatty acids and rosin acids. Whether this principle is applicable further to oil refining remains to be determined. ★ ★ ★

FIG. 1. Photograph of the Heliflow exchanger.

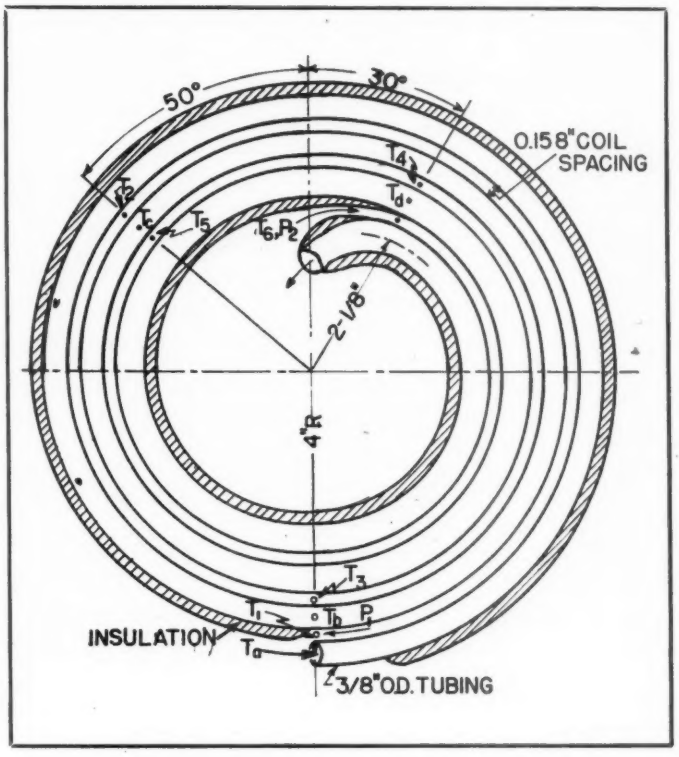


FIG. 2. Dimensions of coils.

HEAT TRANSFER IN SPIRAL COILS

Film coefficients and pressure drops for spiral tubing are much higher than corresponding film coefficients for straight tubes

M. A. NOBLE,* J. S. KAMLANI,† J. J. McKETTA, JR.†

WITHIN recent years heat exchangers have appeared in industry constructed with spiral tubes, rather than in the conventional straight tube arrangement. The available data indicate that the rates of heat transfer and pressure drops are increased by such a procedure, although little quantitative work has been published. The results of an investigation to determine the overall and individual coefficients of heat transfer in a spiral-tube exchanger of the Heliflow type are presented in this paper. The fluids tested were water, gas, oil, and steam. Pressure drops and correlations of heat transfer coefficients are included.

There are no data in the literature that can be applied directly to the type of exchanger under investigation; however, some work has been done on similar types of exchangers, which incorporate the use of spiral or helical passages for the fluids. Richter[14] measured overall heat transfer coefficients and pressure drops for a helically-coiled, double-pipe, water-to-water exchanger. He found both the rates of heat transfer and the pressure drops higher than for straight tubes. Jeschke[8] cooled air in two helical coils of different diameters, measured the air film coefficients and correlated his results mathematically. His correlation indicates a higher rate of heat transfer than for straight tubes. Coons, *et al*,[2] obtained extensive data on heat exchangers of the Rosenblat type. This exchanger is constructed with rectangular annular spaces wound into spirals as paths for the fluids. No tubes are used. Their data for streamline flow show an increase in the rate of heat transfer over that for straight rectangular annular spaces. However, for turbulent flow, no increase was obtained, and they obtained lower pressure drops for both turbulent and streamline flow. Berg and Bonilla[1] used three coils of different sizes to determine the heat transfer coefficients and obtained higher rates of heat transfer at higher values of Graetz number.

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EXCLUSIVE

Experimental Apparatus

The heat exchanger used for all tests in this investigation was a slightly modified 8XF-12 Heliflow, a standard unit manufactured by the Graham Manufacturing Company. Some views of the exchanger are shown in Figs. 1 and 2. The thermal insulation, as shown in Fig. 2, was used to prevent the transfer of heat in the regions where the shell-side water velocity could not be determined accurately. The average thickness of the insulation used was 0.15 in. It is estimated that less than 0.5 per cent of the total heat was transferred through this area. Additional insulation in the form of rubber sheets was placed around, under

and on top of the coils. This prevented heat losses to the atmosphere.

The coil unit consisted of a bank of eight copper tubes wound into a spiral. The tubes were silver soldered to cast bronze manifolds at each end. The total length of each tube was 5.58 ft, the outside diameter was 3/8 in., and the wall thickness was 0.049 in. The outside area through which heat was transferred was 3.10 sq ft. The maximum coil diameter was 7 11/16 in. and the minimum diameter was 4 9/16 in. The eight coils were placed one on top of the other so that the faces of the coils were touching. The coil was wound so that the increase in the coil radius was 0.158 in. per turn; there being approximately 3½ turns in the coil.

Shell-side pressure drop connections were made at P_1 and P_2 as shown in Fig. 2.

Thermocouples were placed in the shell (annular) spaces marked T_2, T_4, and T_5 in Fig. 2. The thermocouples were made of copper and constantan wire. The thermocouples extended less than one-eighth of the distance across the annular space; therefore, the writers believe that any disturbance caused in the flow of the shell fluid did not seriously affect the total heat transferred. The thermocouples were calibrated in place by passing water through the shell side and measuring the inlet and outlet water temperature with calibrated thermometers.

Calibrated thermometers were used to determine the inlet and outlet coil and shell fluid temperatures. Orifice plates were used to measure the coil and shell fluid rates. For runs in which steam was used, calibrated pressure gages were used to determine the line, inlet and outlet pressures. The steam outlet was also provided with a thermometer to determine any subcooling of the condensate. The condensate was removed by means of an inverted bucket condensate trap. A condensate tank and scales were provided so that the amount of steam consumed could be measured. This provided a heat balance on the exchanger.

Methods of Calculation

Method of Determining the Overall Heat Transfer Coefficient

The average overall heat transfer coefficient is defined by

$$q = UA\Delta t_m \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In the following discussion A represents the outside surface area of the tubes, and U is based on this area.

The rate of heat transfer, q, is determined by measuring the rate of flow and the change in temperature of either the shell or coil fluid. Therefore, in order to determine U, it is necessary to know the mean temperature difference Δt_m. As yet, no theoretical expression of the mean temperature difference in terms of the terminal temperatures has been presented for the type of exchanger under investigation. It is possible to determine the true mean temperature difference by measuring the shell and coil fluid temperatures at several points through the exchanger, plotting these temperatures and graphically integrating the area between the two curves. It is relatively easy to measure the shell fluid temperatures by placing thermocouples in the stream at several points through the exchanger. The measurement of the coil-side temperatures presents many mechanical difficulties, however, particularly in installing measuring devices that do not disturb the flow of fluid on either the shell or coil side.

Therefore, the following procedure is used in order to approximate the true mean temperature difference. This procedure involves the measurement of the shell fluid temperature at various points through the exchanger but not the coil fluid temperature.

The length of spiral tubing (Fig. 2) is considered to be divided into four sections; the dividing points are at t_b, t_c, and t_d. It is now assumed that the arithmetic-mean temperature difference will hold over each individual section. The error in this assumption can be made small by using counter-current flow and keeping the ratio of inlet to outlet temperature differences low; under 2, for example. A heat balance can now be made for each individual section, equating the amount of heat transferred into each section of the coil to the heat absorbed in the coil.

Take, for example, the first section of coil between t_a and t_b, as shown in Fig. 2, the hot fluid being on the shell side.

$$q_1 = \frac{(T_1 - t_a) + (T_3 - t_b)}{2} \times U_1A_1 = Wc_p\,(t_b - t_a) \quad . \quad . \quad (2)$$

t_b, an internal coil temperature, is not known, but the shell temperatures, T_1, T_2, T_3, etc., are known.

In the second coil section, between t_b and t_c, the coil is being heated from both sides, giving

$$q_2 = \left(\frac{[(T_1 + T_3)/(2 - t_b) + (T_2 + T_5)/(2 - t_c)]}{2}\right) U_2A_2 = Wc_p\,(t_c - t_b). \quad (3)$$

$$q_3 = \left(\frac{[(T_2 - T_5)/(2 - t_c) + (T_4 - T_6)/(2 - t_d)]}{2}\right) U_3A_3 = Wc_p\,(t_d - t_c). \quad (4)$$

Continuing for the other two sections:

$$q_4 = \left[\frac{(T_4 - t_d) + (T_6 - t_e)}{2}\right] \times U_4A_4 = Wc_p\,(t_e - t_d) \quad . \quad . \quad . \quad (5)$$

Now, if constant values of U and c_p are assumed, there are four unknown terms (U, t_b, t_c, t_d) and four equations that may be solved simultaneously in order to find the values of these terms. t_a and t_e are the inlet and outlet coil fluid temperatures, and are measured easily. W is measured by a flowmeter. Eliminating t_b, t_c, and t_d from the preceding equations (2-5), and substituting numerical values for A_1, A_2, A_3 and A_4 gives

$$U^4\,(1/2)\,(2N + B - C) - U^3\,(Wc_p)\,(-0.33J - 1.84E + 6.96C - 11.03G + 8.41B) + U^2\,(Wc_p{}^2)\,(-6.86J + 3.70E + 22.4B - 16.1C + 44.4N) - U\,(Wc_p)^3\,(11.25J + 11.9E + 19.2B + 12.35C - 77.9G) + (Wc_p)^4\,(50.3)\,N = 0 \quad . \quad . \quad . \quad (6)$$

where

$$N = t_e - t_a$$
$$B = T_1 + T_3$$
$$C = T_4 + T_6$$
$$J = T_2 + T_4 + T_5 + T_6$$
$$E = T_1 + T_2 + T_3 + T_5$$
$$G = t_e + t_a$$

The values of A_1, A_2, A_3 and A_4 used are:

$A_1 = 0.765$ sq ft
$A_2 = 0.946$ sq ft
$A_3 = 0.896$ sq ft
$A_4 = 0.491$ sq ft

Total surface area = 3.098 sq ft

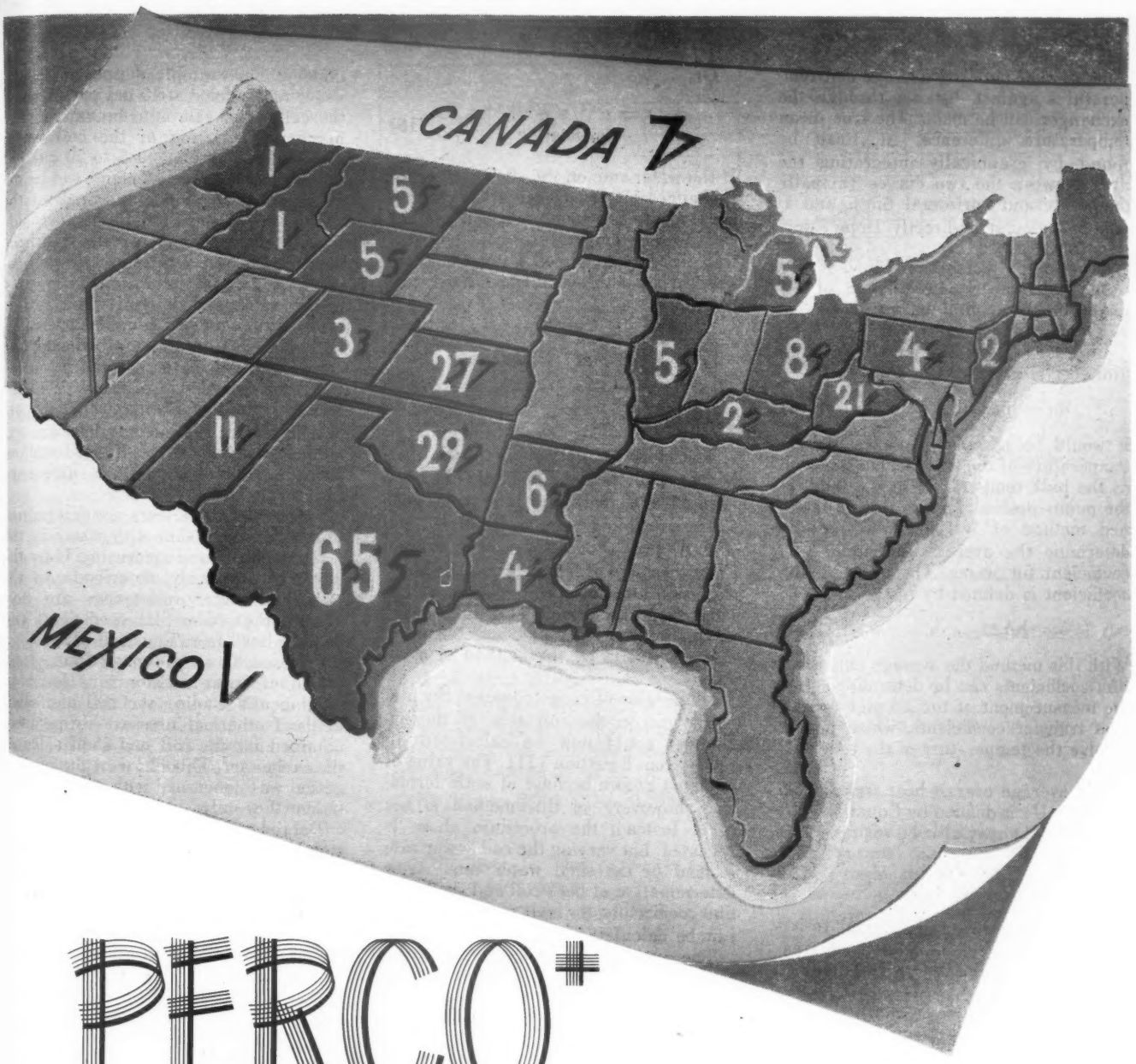
Equation (6) can be solved for U by trial and error, or graphically. A first approximation of U can be obtained by using the value based on the log-mean or arithmetic-mean temperature difference.

For the case with hot water entering the *coils* at t_e and cold water entering the *shell* at T_1, the signs before the second and fourth terms of Equation (6) must be changed, giving

$$U^4\,(1/2)\,(2N - B - C) + U^3\,(Wc_p) \ldots\ldots + U^2\,(Wc_p)^2 \ldots\ldots + U\,(Wc_p)^3 \ldots\ldots + (Wc_p)^4 \ldots\ldots = 0 \quad . \quad . \quad . \quad (7)$$

For the case of heating water with steam, the steam being on the shell side, Equation (7) applies. The steam enters at T_6 and the water enters at t_c. Parallel flow is used for all steam-to-water runs in order to help prevent subcooling of the steam condensate. The change in the saturation temperature of the steam is not great as it passes through the exchanger; therefore, a constant, average shell fluid temperature may be used in Equation (7). This somewhat simplifies the calculations.

For the case of heating water with the steam in the coils, neither Equation (6) nor Equation (7) applies. This can be seen from the heat balances in the derivation of the equations. The outlet and inlet saturation temperatures of the steam in the coils are nearly the same, however, so the arithmetic-mean of these two temperatures may be used as the coil fluid temperature. As the shell fluid (water) temperatures are measured,



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plots of the shell and average coil temperatures against distance through the exchanger can be made. The true mean temperature difference, Δt_m, can be found by graphically integrating the area between the two curves (actually one curve and horizontal line), and U can be calculated directly from Equation (1).

Section 1: Turbulent Flow. Fluids used, water and steam method of determining individual heat transfer coefficients.

In order to determine local individual film coefficients, as defined by

$$dq = h'\Delta t_f' dA \quad . \quad . \quad . \quad . \quad (8)$$

it would be necessary to measure the temperature of the tube surface, as well as the bulk temperature of the fluid, at the points desired. In this work a modified method of Wilson[16] was used to determine the average individual film coefficient for water. The average film coefficient is defined by

$$q = hA\Delta t_f \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

With this method the average individual film coefficients can be determined from the measurement of the average overall heat transfer coefficients, which do not involve the temperature of the tube surface.

The average overall heat transfer coefficient (U) is defined by Equation (1). Equation (1) may also be expressed as

$$q = \frac{A\Delta t_m}{R_t} \quad . \quad . \quad . \quad . \quad (10)$$

where R_t is the overall thermal resistance per square foot of surface area, and is equal to the sum of the individual thermal resistances. The individual resistances include the resistance of the fluid inside the coil, the wall and scale resistances, and the resistance of the fluid outside the coil

$$R_t = \frac{1}{U} = r' + r_w + r = \frac{A}{h'A'} + r_w + \frac{1}{h} \quad . \quad . \quad (11)$$

Dittus and Boelter[3] have correlated experimental values of h for straight tubes, and it will be assumed for the moment that the same type of equation will apply to spiral tubes

$$hD/k = a(DG/\mu)^{0.8}(c_p\mu/k)^{0.4} \quad \text{for heating} \quad . \quad . \quad . \quad . \quad (12)$$

$$hD/k = a(DG/\mu)^{0.8}((c_p\mu/k)^{0.3} \quad \text{for cooling} \quad . \quad . \quad . \quad . \quad (13)$$

Therefore, for any given tube diameter, h can be expressed as a function of the water rate and thermal properties of the fluid.

$$h = a'W^{0.8}k^{0.6}/\mu^{0.4} \quad \text{for heating} \quad . \quad . \quad (14)$$

$$h = a'W^{0.8}k^{0.7}/\mu^{0.5} \quad \text{for cooling} \quad . \quad . \quad (15)$$

Or

$$r = \mu^{0.4}/a'W^{0.8}k^{0.6} \quad \text{for heating} \quad . \quad . \quad (16)$$

If the water rate on the shell side of the exchanger is varied over a wide range, keeping the coil water rate and average coil water temperature constant, the wall resistance and coil water resistance will remain substantially constant, giving

$$1/U = R_t = \mu^{0.4}/a'W^{0.8}k^{0.6} + b \quad \text{(constant) for heating} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

where $b = r_w + r'$

Therefore a plot of 1/U vs. $\mu^{0.4}/W^{0.8}k^{0.6}$, for heating data, should be a straight line, with the intercept equal to b. For cooling data, a plot of 1/U vs. $\mu^{0.5}/W^{0.8}k^{0.7}$ should be a straight line. From the value of b as determined above, shell-side film coefficients can be calculated from Equation (11). In this investigation the value of b is determined mathematically by the method of averages.

If the value of r_w were known, the film coefficient on the coil side of the exchanger could now be calculated directly from Equation (11). The value of r_w is not known because of scale formation, however; so this method is not used. Instead, the procedure above is repeated, but varying the coil water rate instead of the shell water rate. After determination of both coil and shell side film coefficients, the wall resistance (r_w) can be calculated from Equation (11).

The correlation of the results substantiates the use of Equations (12) and (13).

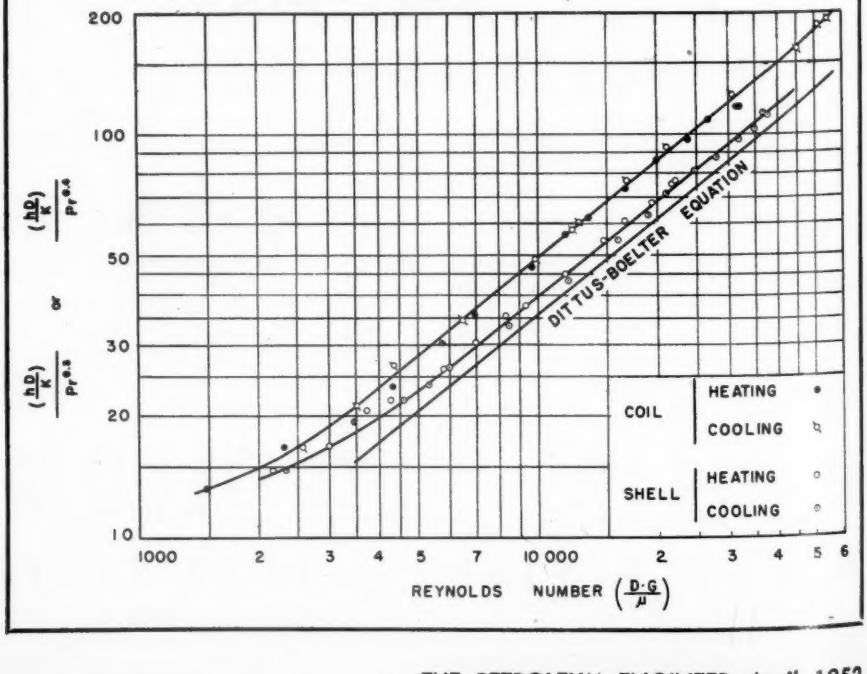
The range of water velocities that can be used in the Wilson plot is limited by the fact that the ratio of inlet to exit temperature differences must remain under 2. For example, suppose the shell water rate is fixed at 10 gal per min and the coil water rate is to be varied. The maximum variation of the coil water rate will be from about 5 to 20 gal per min. Coil-side film coefficients can be determined at 3 gal per min without the use of the Wilson Plot. If the *shell* side film coefficient has previously been measured at water rates as low as 6 gal per min, the shell water rate is lowered to this value and the coil water rate is lowered to 3 gal per min. The overall U is then measured and the coil-side film coefficient calculated from Equation (11) and knowledge of the wall resistance, r_w. In this manner the data obtained from the Wilson plots are extended to any water rate desired without exceeding the temperature difference ratio of 2.

Steam film coefficients are determined by condensing steam with water in the test exchanger and measuring U by the methods previously described. As the wall and water resistances are now known, the steam film coefficients can be calculated from Equation (11).

Discussion of Results. Data were taken on water-to-water runs for both heating and cooling the coil and shell fluids. Isothermal pressure drops were obtained for the coil and shell sides of the exchanger. This phase of the investigation was concerned with water in turbulent flow only.

Data were taken on steam-to-water runs with steam in the coils and in the shell. It is to be expected from both theory and previous investigations[7,11] that the steam film coefficients will depend upon the rate of heat transfer and the steam velocity through the exchanger as well as the thermal properties of the steam. Therefore, data were taken by varying the rate of heat transfer at fixed inlet steam velocities of approximately 100, 200, and 300 ft per second. This was accomplished by cal-

FIG. 3. Heat transfer coefficients.



culating beforehand the steam pressure required to give a certain inlet velocity for each value of the rate of heat transfer used.

Water-to-Water Heat Transfer. A correlation of the results is given in Fig. 3, where $(hD/k)/Pr^{0.4}$ is plotted against Reynolds numbers for heating data and $(hD/k)/Pr^{0.3}$ is plotted against Reynolds numbers for cooling data. The slope of the lines is 0.8, and the heating and cooling data are brought together by the use of $Pr^{0.4}$ and $Pr^{0.3}$. This verifies the use of Equations (12) and (13) in the construction of the Wilson plots. The data cover a range of Reynolds numbers of from 1500 to 55,000 on the coil side of the exchanger and from 2200 to 38,000 on the shell side. An equivalent diameter of 0.0233 ft is used for the annular channel. This value is obtained by dividing the annular cross-section by the total wetted perimeter in order to obtain the hydraulic radius. The equivalent diameter is equal to four times the hydraulic radius. A comparison of the rate of heat transfer with that in straight tubes is made in each plot. The plot for straight tubes is the Dittus-Boelter equation[3]. The film coefficients inside the spiral tubes are 36 per cent greater than for straight tubes. The film coefficients on the annular side are 7.5 per cent greater than values given by the Dittus-Boelter equation. The results of this investigation agree with published data on similar types of equipment [2,8,14] in that higher rates of heat transfer are obtained in curved tubes than in straight tubes.

The results of the coefficients inside the tubes can be expressed

$$\text{by } (hD/k) = 0.0313\ (Re)^{0.8}\ (Pr)^{0.4} \quad \text{for heating} \quad \ldots\ldots\ldots\ldots\ (18)$$

$$\text{and } (hD/k) = 0.0313\ (Re)^{0.8}\ (Pr)^{0.3} \quad \text{for cooling} \quad \ldots\ldots\ldots\ldots\ (19)$$

These equations hold for Reynolds numbers down to 3500 with a maximum deviation of 6.8 per cent and an average deviation of 2.4 per cent.

The results of the shell-side film coefficients can be expressed

$$\text{by } (hD_e/k) = 0.0247\ (Re)^{0.8}\ (Pr)^{0.4} \quad \text{for heating} \quad \ldots\ldots\ldots\ldots\ (20)$$

$$\text{and } (hD_e/k) = 0.0247\ (Re)^{0.8}\ (Pr)^{0.3} \quad \text{for cooling} \quad \ldots\ldots\ldots\ldots\ (21)$$

These equations hold for Reynolds numbers down to 4500 with a maximum deviation of 4.3 per cent and an average deviation of 2.6 per cent.

The data of Jeschke[8] for cooling air in helical coils indicate that the film coefficients in helical coils may be obtained by multiplying the value in straight tubes by $(1 + 3.5D/D_H)$, where D is the tube diameter and D_H is the diameter of the helix. Assuming that this relation will apply to spiral tubes, and using an average coil diameter of 6⅛ in. for D_H, a value of $(1 + 8.0D/D_c)$ is obtained for water in spiral tubes. For water in the spiral annular space, a value of $(1 + 1.6D_e/D_c)$ is obtained.

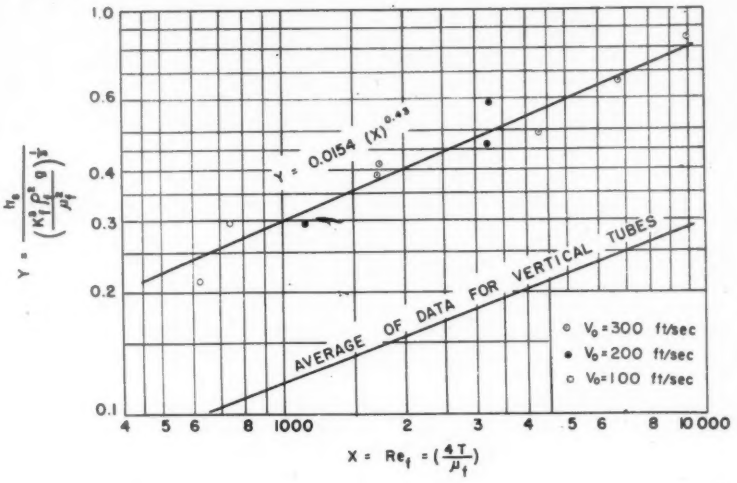


FIG. 4. Kirkbride type plot for coils.

Therefore, the data for the coil-side coefficients can be given by

$$(hD/k) = 0.023\ (1 + 8.0D/D_c) \times (Re)^{0.8}\ (Pr)^{0.4} \quad \ldots\ldots\ (22)$$

and the date for the shell-side coefficients can be given by

$$(hd/k) = 0.023\ (1 + 1.6D/D_c) \times (Re)^{0.8}(Pr)^{0.4} \quad \ldots\ldots\ (23)$$

For cooling data the exponent of the Prandtl number is 0.3.

Steam-to-Water Heat Transfer Coefficients. Values of the steam film coefficients of heat transfer range from 1313 to 7090 Btu/hr-ft²-°F on the coil side of the exchanger. Kirkbride[10] has correlated data for condensing vapors on vertical tubes with an equation of the type

$$Y = aX^b \quad \ldots\ldots\ldots\ (24)$$

where a and b are constants and

$$Y = h_s\ (\mu^2_f/k^3_f\rho^2_f g)^{1/3}$$

$$X = 4T/\mu_f = Re_f$$

Although the application of this method to spiral tubes may be without any theoretical basis, the data obtained in this investigation can be correlated by such a procedure. The data for steam in coils may be expressed by

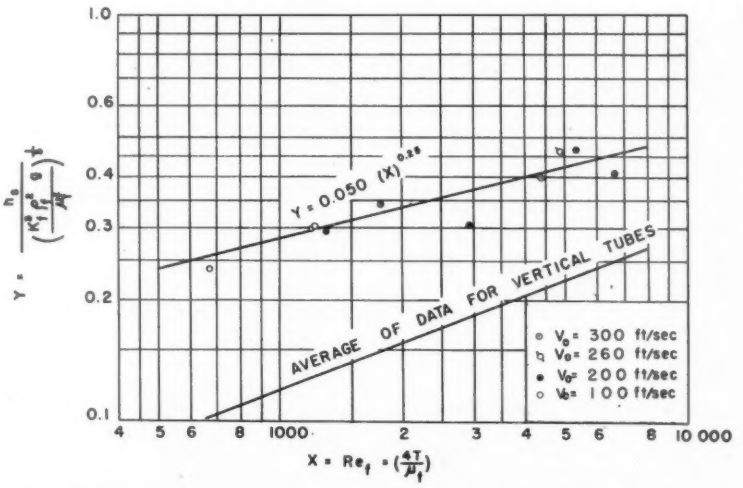
$$Y = 0.0154X^{0.43} \quad \ldots\ldots\ldots\ (25)$$

with a maximum deviation of 18 per cent and an average deviation of 8.7 per cent. The data for steam in the shell side of the exchanger may be given by

$$Y = 0.050X^{0.25} \quad \ldots\ldots\ldots\ (26)$$

with a maximum deviation of 17 per

FIG. 5. Kirkbride type plot for shell.



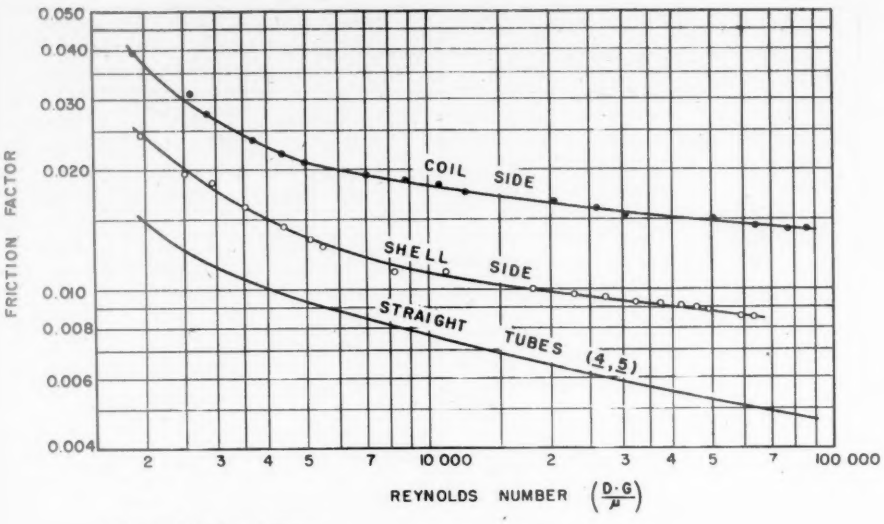


FIG. 6. Friction factors.

cent and an average deviation of 6.7 per cent. Equation (25) applies to values of Re_f from 619 to 9920. Equation (26) applies to values of Re_f of from 672 to 6640. Figs. 4 and 5 give the resulting correlations.

The effect of the steam velocity is not apparent in Figs. 4 and 5. This is probably due to the narrow range of Re_f obtained at low steam velocities (100 ft per sec). A plot of the average of results for vapors condensing on vertical tubes is presented in Figs. 4 and 5 for comparison. The values of Y obtained in this investigation are from 75 per cent to 175 per cent greater for a given Re_f than the values for vertical tubes with zero steam velocity.

All heat balances on steam-to-water runs check within 5 per cent. It was not practical to keep the ratio of inlet to exit temperature differences with 2/1 for these runs; so the error involved in the use of Equation (6) and (7) is greater than for water-to-water runs. The maximum ratio of inlet to outlet temperature differences used is 5/1.

All of the steam temperatures used in the calculation of the steam film coefficients are based on the saturation temperature of the steam. On expanding saturated steam at the line pressure of 100 psig to low entrance pressures, however, (5 psig for example) the steam will become superheated, and the actual temperature will be higher than the saturation temperature corresponding to the entrance pressure. McAdams[13] reviews the results of several investigations on the film coefficients of condensing superheated vapors, and states that little error is made in calculating the rate of heat transfer from the film coefficient of the saturated steam and the temperature difference based on the saturation temperature of the steam. In condensing steam with 180 F superheat, the rate of heat transfer is only 3 per cent greater than the value for condensing saturated steam at the same pressure and wall temperature. The maximum superheat obtained on any run in this investigation is 70 F.

Pressure Drop. The results of the pressure drop measurements are expressed as friction factors, f, defined by

$$dF/dL = 4fV^2/2g_cD \quad . \quad . \quad . \quad . \quad (27)$$

Plots of f vs. Reynolds numbers for both shell and tube sides of the test exchanger are given in Fig. 6. The data of Drew, *et al.*, and Drew and Generaux[4] for straight tubes are presented for comparison. The tube-side pressure drop is from 150 to 195 per cent greater than for straight tubes, and the shell-side pressure drop is from 63 to 69 per cent greater than for straight annular spaces. It was necessary to correct the tube-side pressure drop data for entrance and exit losses in the manifolds. This correction is small, however, (about 4 per cent of the total pressure drop); so any inaccuracies involved in making this correction should not seriously affect results.

Section II: Viscous Flow. Fluids: Oil and Water.

Physical Properties of Test Oil

The oil used in this investigation was straight run gas oil from East Texas crude. The viscosity of the oil was determined by means of a modified Ostwald Viscosimeter and the following values were obtained.

Temperature, °F	98.8	130.6	179.8
μ', centistokes	7.75	4.835	2.79

The specific gravity of the test oil was determined by means of a Westphal balance and the following values were obtained:

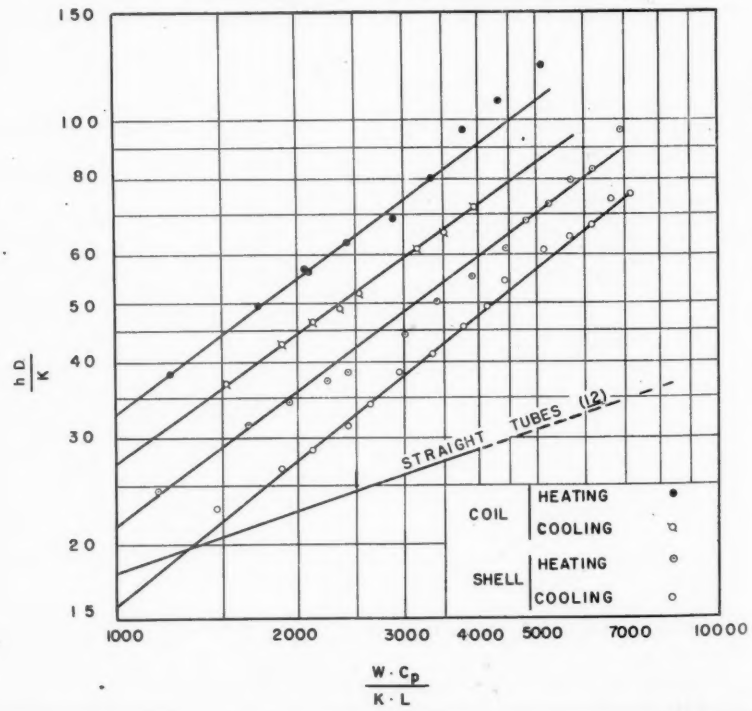
Temperature, °F	Specific Gravity 60/60
60.0	0.8653
77.0	0.8606
95.3	0.8531
111.4	0.8474
125.2	0.8427
140.7	0.8358
160.0	0.8287
180.0	0.8203

The API gravity of the oil was 32.0 and the characterization factor was 11.85. The thermal conductivity and specific heat were obtained from Kern[9].

Data were taken with oil in the coils and water in the shell, for both heating and cooling of oil. Then the system was reversed, the oil on the shell side and the water in the coils, for both heating and cooling of oil. Isothermal pressure drops were obtained for oil in the coils and on the shell side of the exchanger.

Heat Transfer Coefficients. The film coefficients were determined by the method outlined in Section I of this

FIG. 7. Correlation of heat transfer coefficients.



Another HUDSON-BUILT PLANT

Processing 65 Million Cubic Feet of Gas Per Day In the Dollarhide Field

This plant, the most recent of the more than 100 major projects completed by HUDSON, processes all the gas produced in the Dollarhide oil field of Andrews County in West Texas. The gas is compressed to 650 pounds per square inch and treated to remove Hydrogen Sulphide, after which about half of the gas is used for gas lift, and half processed for removal of at least 75% of the propane and essentially 100% of the butanes and natural gasoline.

The plant was designed and constructed by HUDSON in collaboration with engineers of The Pure Oil Company.

HUDSON
ENGINEERING CORPORATION
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paper. These coefficients were correlated by the use of the Graetz number.

$$\frac{hD}{k} = a\left(\frac{Wc_p}{kL}\right)^c \quad . \quad (28)$$

The experimental runs used for calculations were those for which the heat balances checked within 3 per cent. For all of the Wilson plot runs, the maximum deviation from the average of the constant water rate was 0.5 per cent. The maximum deviation from the mean bulk temperature was 2.1 F.

Fig. 7 shows the resulting correlation when (hD/k) is plotted against the Graetz number. The slope of this plot is approximately 0.8, which is to be expected since Equations (12) and (13) were used in the construction of Wilson plots. The data cover a range of Graetz number from 1200 to 5000 on the coil side and from 1200 to 7000 on the shell side of the heat exchanger. The figures correspond to Reynolds numbers of 569 to 2516 on the coil side and 347 to 2898 on the shell side. The plot for straight tubes[12] is given for comparison with results of this investigation.

The film coefficients for the coil side can be expressed by

$$(hD/k) = 0.215\ (Wc_p/kL)^{0.741} \quad \text{for heating} \quad . \quad (29)$$

and

$$(hD/k) = 0.200\ (Wc_p/kL)^{0.708} \quad \text{for cooling} \quad . \quad (30)$$

Equation (29) holds for a range of Graetz number from 1200 to 5000 with a maximum deviation of 9.5 per cent. The film coefficients for heating oil in the coils are 97 to 248 per cent greater than for straight tubes. Equation (30) holds for a range of Graetz number from 1500 to 4000 with maximum deviation of 2 per cent. The film coefficients for cooling oil in coils are 77 to 154 per cent greater than for straight tubes.

The film coefficients for the annular space can be expressed by

$$(hD/k = 0.130\ (Wc_p/kL)^{0.732} \quad \text{for heating} \quad . \quad (31)$$

and

$$(hD/k) = 0.068\ (Wc_p/kL)^{0.800} \quad \text{for cooling} \quad . \quad (32)$$

Equation (31) holds for range of the Graetz number from 1150 to 7000 with a maximum deviation of 6.2 per cent. The film coefficients for heating oil in the shell are 29 to 160 per cent greater than for straight tubes. Equation (32) holds for a range of Graetz number from 1500 to 7000 with a maximum deviation of 5.6 per cent. The film coefficients for cooling oil in the shell are 12 to 115 per cent greater than for straight tubes. The correlations obtained in this investigation agree with published data on similar types of equipment[1,2,14] in that higher rates of heat transfer are obtained in curved tubes than in straight tubes.

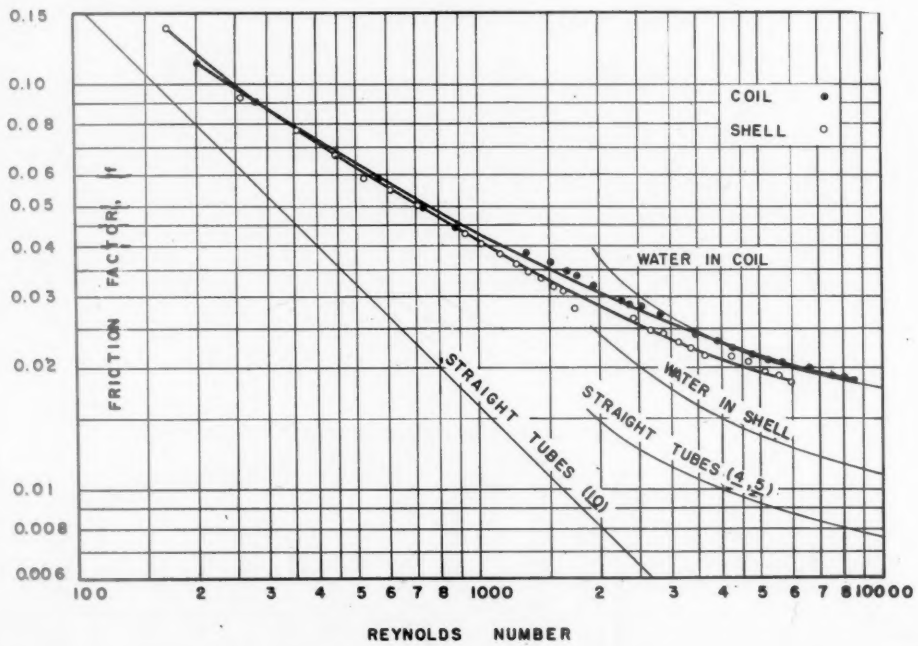
Pressure Drops. The friction factor, f, defined by Equation (27), is used to express results of pressure drop measurement.

$$dF/dL = 4fV^2/2g_cD \quad . \quad . \quad . \quad . \quad (27)$$

Fig. 8 gives the resulting correlation when friction factor, f, is plotted against Reynolds number. The data of Drew, *et al.*,[4,5] for straight tubes in turbulent region and the theoretical relationship for streamline flow in circular pipes[10a] are presented for comparison. The correlations for pressure drops, obtained in Section I of this investigation are also presented for comparison. The tube side pressure drops within the range of Reynolds number from 200 to 2000 is 44.7 to 228 per cent greater than for straight tubes and with decrease in Reynolds number tend to approach the values for straight tubes. As the Reynolds number increases the friction factor approaches the value obtained with water in the coil.

The shell side pressure drop, within the range of 160 to 2000 Reynolds number is 43.7 to 246 per cent greater than for straight tubes. With an increase in the Reynolds number, however, the values of the friction factors obtained in this investigation are 46 per cent greater than those obtained for the water runs in Section I at a Reynolds number of 6000.

FIG. 8. Friction factors.



Acknowledgment

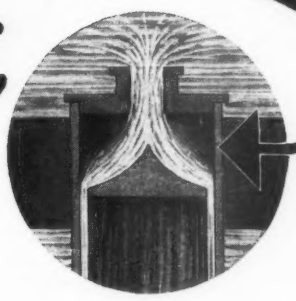
Gulf Oil Corporation provided the gas oil used in this investigation. Graham Manufacturing Company provided the Heliflow exchangers used.

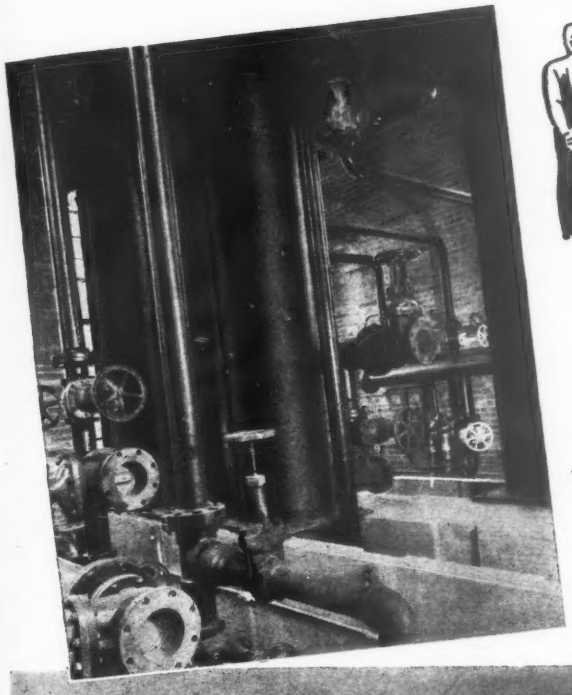
Nomenclature

- A = Total outside surface area of tubes, sq ft.
- $\{A_1, A_2\}$ / $\{A_3, A_4\}$ = Outside surface area of tubes between t_a and t_b, t_b and t_c, t_c and t_d, t_d and t_e in Fig. 2, sq ft.
- a, a' = Constants.
- B = Term in Equations (6) and (7), equals $T_1 + T_3$, °F.
- b = Wilson plot intercept, $\frac{\text{hr. ft.}^2\ ^\circ\text{F.}}{\text{Btu}}$
- C = Term in Equations (6) and (7), equals $T_4 + T_6$, °F.
- c = Constant.
- C_p = Specific heat at constant temperature, Btu/lb. — °F.
- D = Inside diameter of tube, ft.
- D_e = Equivalent diameter of annular space, ft.
- Δt_m = True mean temperature difference, °F.
- E = Term in Equations (6) and (7), equals $T_1 + T_2 + T_3 + T_5$, °F.
- F = Friction loss, ft of fluid.
- f = Friction factor, dimensionless.
- G = Term in Equations (6) and (7), equals $t_a + t_c$, °F; also mass velocity, lb/sec — ft².
- g_c = Gravitational constant, 32.2 (lb mass) (ft)/lb force) sec².
- h = Average individual heat transfer coefficient, Btu/hr — ft² — °F.
- h_s = Average steam film coefficient, Btu/hr — ft² — °F.
- J = Term in Equations (6) and (7), equals $T_2 + T_4 + T_5 + T_6$, °F.
- k = Thermal conductivity, Btu/hr — ft — °F.

Dirty Water can't "Shut-down"...

Vogt

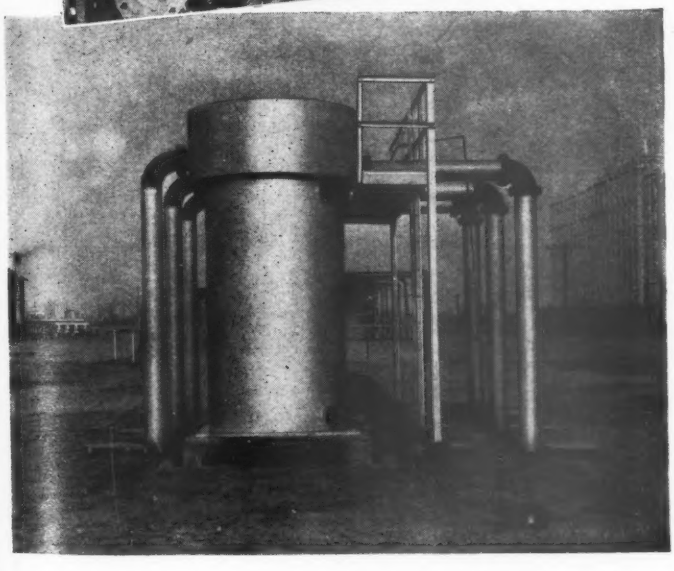




film type exchangers

(Condensers—Coolers—Evaporators)

Patent Nos. 1,935,270 - 2,057,597 - 2,424,441



River water, well water or brackish water are all alike to this exchanger *because it can be cleaned* while in operation! The water distributing ferrules need only be removed successively for the cleaning brush or tool whereby the tubes receive additional water which sluices away the dislodged dirt.

Vogt Film Type Exchangers are operating with real economy of first cost, operation and maintenance in power, petroleum, and chemical industries. They serve as Jacket Water Coolers, Feed Water Heaters, Hydrocarbon Evaporators, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to cool or heat any liquid and to condense or evaporate any fluid.

TOP: *Four units at Newton Falls, Ohio Municipal plant cool water for diesel engines and a lubricating oil cooler.*

BOTTOM: *Jacket Water Coolers serving engines of 7,300 HP in the compression plant of a Western Oil Refinery.*

[Bulletin HE-7 describes typical installations of Vogt Film Type exchangers and is available upon request.]

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.

CORROSION

CHEMICAL RESISTANCE OF "KARBATE" PRODUCTS

This table shows the grade of "Karbate" Impervious Graphite and the type of "National" Resin Base Cement recommended for commercial use in the more common corrosive chemicals. The concentrations and temperatures listed are based on field and laboratory experience, but *the satisfactory use of these materials is not limited to the chemical reagents or conditions shown in this table.*

Chemical Reagent	Concentration	Fluid Temperatures up to	Recommendation	
			Grade	Cement
ACIDS				
Acetic acid	All	Boiling	22	14
Acetic anhydride	100%	Boiling	22	14
Arsenic acid	All	Boiling	22	14
Boric acid	All	Boiling	22	14
Carbonic acid	0-10%	200° F	22	14
Chromium trioxide, aq. soln.	All	Boiling	22	14
Citric acid	All	Boiling	22	14
Formic acid	All	Boiling	22	14
Hydrobromic acid	0-48%	Boiling	22	14
Hydrochloric acid	48-60%	185° F	x	14
Hydrofluoric acid	Over 60%	—	22	14
Hydrofluoric acid	All	Boiling	22	14
Hydrofluoric acid	All	212° F	22	(†)
Hydrogen sulphide-water	100%	185° F	22	(†)
Lactic acid	0-10%	140° F	x	14
Monochloracetic acid	10-20%	—	22	14
Nitric acid	Over 20%	Boiling	22	14
Nitric acid	100%	Boiling	22	14
Nitric acid	All	Boiling	21	14
Oleic acid	0-85%	Boiling	22	14*
Oxalic acid	100%	Boiling	22	(†)
Phosphoric acid	0-75%	338° F	x	
Stearic acid	75-96%	—	22	14
Sulfuric acid	Over 96%	Room	22	14
Sulfuric acid	All	Boiling		
Sulfuric acid	All			
Sulfurous acid				
Tartaric acid				
ALKALIES				
Ammonium hydroxide	All	Boiling	22	15
Monethanolamine	All	Boiling	22	15
Sodium hydroxide	0-67%	Boiling	21	15
Sodium hydroxide	67-80%	275° F	21	15
Tetramine C	All	Boiling		
SALT SOLUTIONS				
Aluminum Chloride	All	Boiling	22	14
Ammonium thiocyanate	0-63%	Boiling	22	14
Arsenic trichloride	100%	230° F	x	
Calcium chlorate	0-10%	140° F	22	14
Calcium hypochlorite	All	90° F	22	14
Cupric chloride	All	Boiling	22	14
Ferric chloride	All	Boiling	22	14
Ferrous chloride	All	Boiling	22	14
Ferrous sulphate	All	Boiling	22	14
Manganous sulphate	All	Boiling	22	14
Nickel chloride	All	Boiling	22	14
Nickel sulphate	100%	Boiling	22	14
Phosphorus trichloride	All	Room	21	—
Sodium chloride	0- 4%	Boiling	22	14
Sodium chlorite	0-25%	Boiling	22	14
Sodium hypochlorite	All	Boiling	22	14
Stannic chloride	All	Boiling	22	14
Zinc ammonium chloride	All			
Zinc chloride	All			
Zinc sulfate				
HALOGENS, AIR, WATER				
Air	—	338° F	22	14
Bromine	100%	Room	x	
Bromine water	All	Room	22	14
Chlorine—dry	100%	Room	22	14
Chlorine water	All		x	
Iodine	100%		x	
Fluorine	100%			

Chemical Reagent	Concentration	Fluid Temperatures up to	Recommendation	
			Grade	Cement
HALOGENS, AIR, WATER cont.				
Steam	—	338° F	22	14
Water	—	Boiling	22	14
ORGANIC COMPOUNDS				
Acetone	0-100%	Boiling	22	14
Amyl alcohol	100%	Boiling	22	14
Aniline	0-60%	338° F	22	14
Aniline hydrochloride	100%	Boiling	22	14
Benzene	100%	212° F	22	14
Benzene hexachloride	100%	Boiling	22	14
Butyl alcohol	0-100%	Boiling	22	14
Butyl "Cellosolve"*	100%	Boiling	22	14
Carbon tetrachloride	0-100%	257° F	21	14
"Cellosolve"*	100%	Boiling	22	14
Chlorethylbenzene	100%	140° F	22	14
Chloroform	—	338° F	22	14
Deoxidine	100%	Boiling	22	14
Dowtherm	0-100%	Boiling	22	14
Dioxan	0-100%	122° F	22	14
Ethyl alcohol	0-8%	200° F	22	14
Ethylene chlorohydrin	100%	Boiling	22	14
Ethylene dibromide	100%	Boiling	22	14
Ethylene dichloride	Saturated	Room	22	14
Ethyl mercaptan—water	100%	Boiling	22	14
Freon 11 and 12	100%	338° F	22	14
Gasoline	0-100%	Boiling	22	14
Glycerine	100%	Boiling	22	14
Isopropyl acetate	0-100%	Boiling	22	14
Isopropyl alcohol	100%	Boiling	22	14
Isopropyl ether	100%	Boiling	22	14
Kerosene	All	Boiling	22	14
Mannitol	100%	Boiling	22	14
Methyl isobutyl ketone	0-100%	Boiling	22	15
Methyl alcohol	100%	Boiling	22	14
Monochlor benzene	100%	Boiling	22	14
Octyl alcohol	100%	Boiling	22	14
Paradichlorbenzene	100%	Boiling	22	14
Paraldehyde	100%	Boiling		
Tetrachlorethane, sym.	100%			
Trichlorethylene				
MIXTURES				
Ammonium persulfate plus sulfuric acid	25%	Room	22	14
Calcium chloride plus calcium chlorate	20%	140° F	22	14
Chloronated ethyl alcohols	30%	Boiling	22	15
Chrome plating solns.	10%		x	
Hydrochloric acid	All	Boiling	22	14
sat. with chlorine	All	Boiling	22	14
Nickel plating solns. (chloride)	Over 20%	Boiling	22	14
Nickel plating solns. (sulfate)	All	140° F	22	(†)
Nitric acid plus hydrofluoric acid	All	Boiling	22	14
Oakite acid materials—O.C. 32, O.C. 33, O.C. 36, O.C. 84A, O.C. 84M, CRYS. 87, O.C. 88	15%	Boiling	22	14
Parkerizing solution	5%	Boiling	21	—
Rayon Spin bath	All		x	
Sodium hypochlorite plus sodium hydroxide	All			
Sulfuric acid plus nitric acid	0-25%			
	96% .03%			

(x) Not recommended

NOTE: (†) "National" No. 14 Cement used with threaded joints will give serviceable life.
(*) The term "Cellosolve" is a registered trade-mark of Union Carbide and Carbon Corporation.

The terms "National" and "Karbate" are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY • A Division of Union Carbide and Carbon Corporation
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District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
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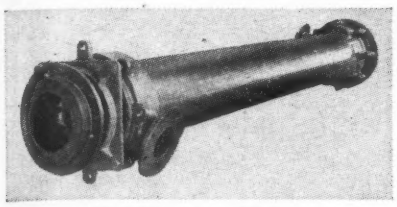
...AND THE CONSERVATION OF CRITICAL MATERIALS

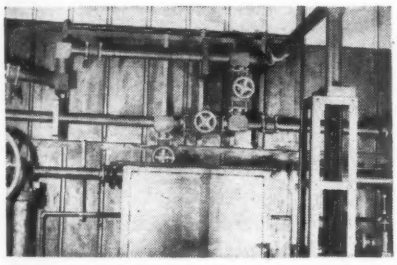
INSTALL NATIONAL TRADE-MARK carbon and graphite and "Karbate" impervious graphite equipment for processing, conveying and storage of corrosive fluids.

IMMUNE TO THERMAL SHOCK • LIGHT WEIGHT • NO METALLIC CONTAMINATION • LONG LIFE—LOW MAINTENANCE



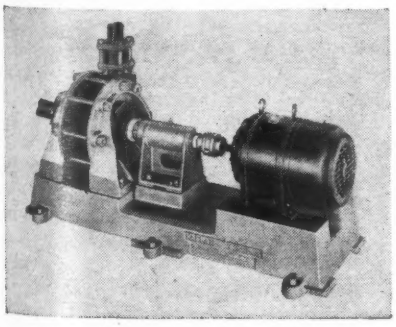
HEAT EXCHANGERS

Wide variety of standard and custom built models in time-proven designs. Shell and tube, cascade, concentric and immersion types available in stock sizes. High rates of heat transfer. Catalog Sections S-6620, S-6690, S-6715, S-6716, S-6750, S-6780.



PIPE, FITTINGS AND VALVES

Complete standard line to handle your toughest fluid conveying requirements. Easy to install and maintain with simple hand tools. Catalog Section S-7000.

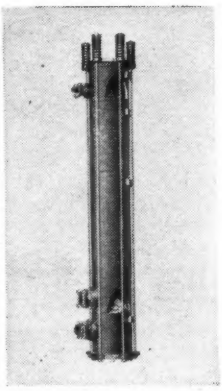


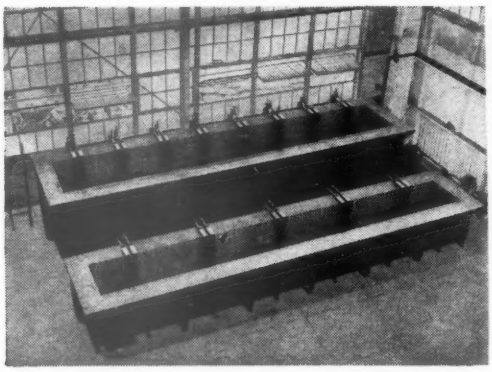
PUMPS

The centrifugal pump for handling corrosive fluids—rugged design, simple construction, trouble-free rotary seal. Handling capacities to 800 G. P. M. Catalog Section S-7200.

TOWERS

"Karbate" impervious graphite towers for absorption, fractionation, extrusion, scrubbing and many other processing operations. Easily erected from standardized monolythic sections and components. Catalog Section S-7350.



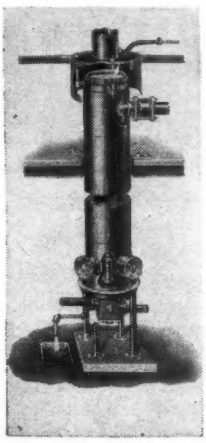


BRICK

Accepted material for lining tanks, towers, digesters and other vessels containing corrosive chemicals. Catalog Section S-6210.

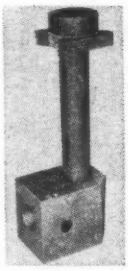
HCL COMBUSTION CHAMBERS

Versatile, standardized line for hydrogen chloride synthesis. Burns moist gas. Simplicity of operation. Catalog Section S-7530.



STEAM JETS

Withstand severe corrosive conditions and thermal shock in heating and agitating corrosive solutions by direct injection of steam. Catalog Section S-7300.

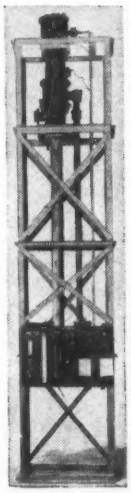


GROUND ANODES

"National" Graphite Ground Anodes for cathodic protection of buried, submerged or exposed metallic structures provide for control of current input to meet specific environmental conditions. Catalog Section S-6510.

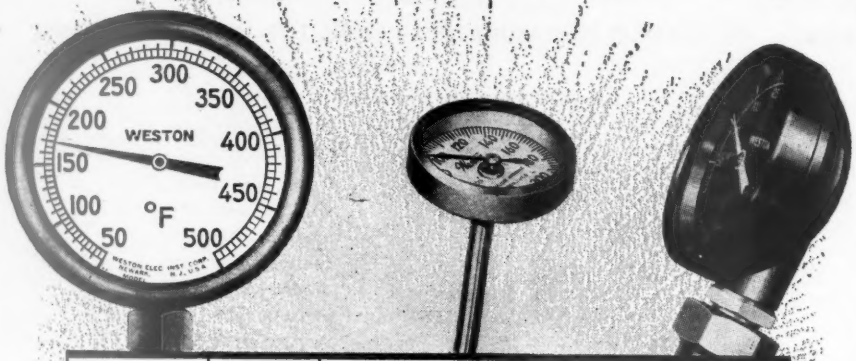
HCL ABSORBERS

Standard and custom built models to meet *any* hydrochloric acid production requirement. Falling-film principal of absorption — proven efficient and compact design. More HCL produced in "Karbate" absorbers than in all other types combined. Catalog Section S-7430.

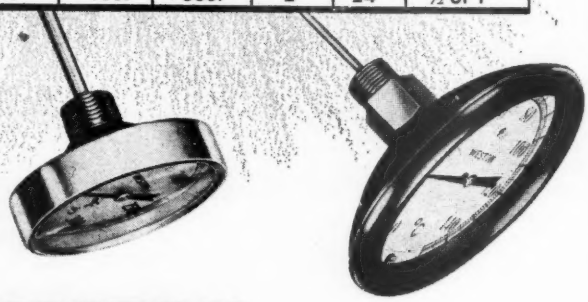


Available

in broadest selection of types, ranges, stem lengths



TYPE	SCALE LENGTH	RANGES As low as	RANGES As high as	STEM LENGTH As short as	STEM LENGTH As long as	% ACCURACY OF THERMO. RANGE
Heavy Duty Straight Form	9"	—100F	+1000F	2½"	48"	1
Heavy Duty Angle Form	9 or 12"	—100F	+1000F	2½"	72"	1
Standard Angle Form	6"	—100F	+1000F	2½"	72"	1
General Purpose	4½"	—100F	+1000F	2½"	36"	1
Laboratory	3.40"	—100F	+500F	2"	24"	½ of 1



WESTON

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9234

k_f = Thermal conductivity at average film temperature, Btu/hr — ft — °F.
L = Length of tubing or pipe, ft.
N = Term in Equations (6) and (7), equals $t_c - t_a$, °F.
P_1, P_2 = Location of shell-side pressure taps in Fig. 2.
Pr = Prandtl number, dimensionless, equals $c_p \mu/k$.
q = Rate of heat transfer, Btu/hr or Btu/min.
r = Shell-side thermal resistance, equals 1/h.
r′ = Coil-side thermal resistance, equals $(A/A')/h'$.
r_w = Thermal resistance of wall and scale.
R_{ef} = $4\,T/\mu_f$, dimensionless.
R_t = Overall thermal resistance, equals 1/U.
ρ = Density of fluid, lb/cu ft.
ρf = Density of condensate at average film temperature.
T = Mass rate of flow per unit perimeter, lb/sec — ft.
$T_{1\text{-}6}$ = Shell-side temperatures at fixed location as shown in Fig. 2, °F.
$t_{a\text{-}e}$ = Coil-side temperatures at fixed locations as shown in Fig. 2, °F.
U = Overall heat transfer coefficient, Btu/hr — ft² — °F.
μ = Viscosity, centipoise or lb/sec — ft.
μ_f = Viscosity, evaluated at average film temperature.
V = Velocity, ft/sec.
V_o = Entering steam velocity, ft/sec.
W = Water rate, lb/min.
X = Abscissa on graph, equals $4\,T/\mu_f = R_{ef}$.
Y = Ordinate on graph, equals $h_s(\mu^2_f/k^3_f\,{}^2_f g)^{1/3}$.

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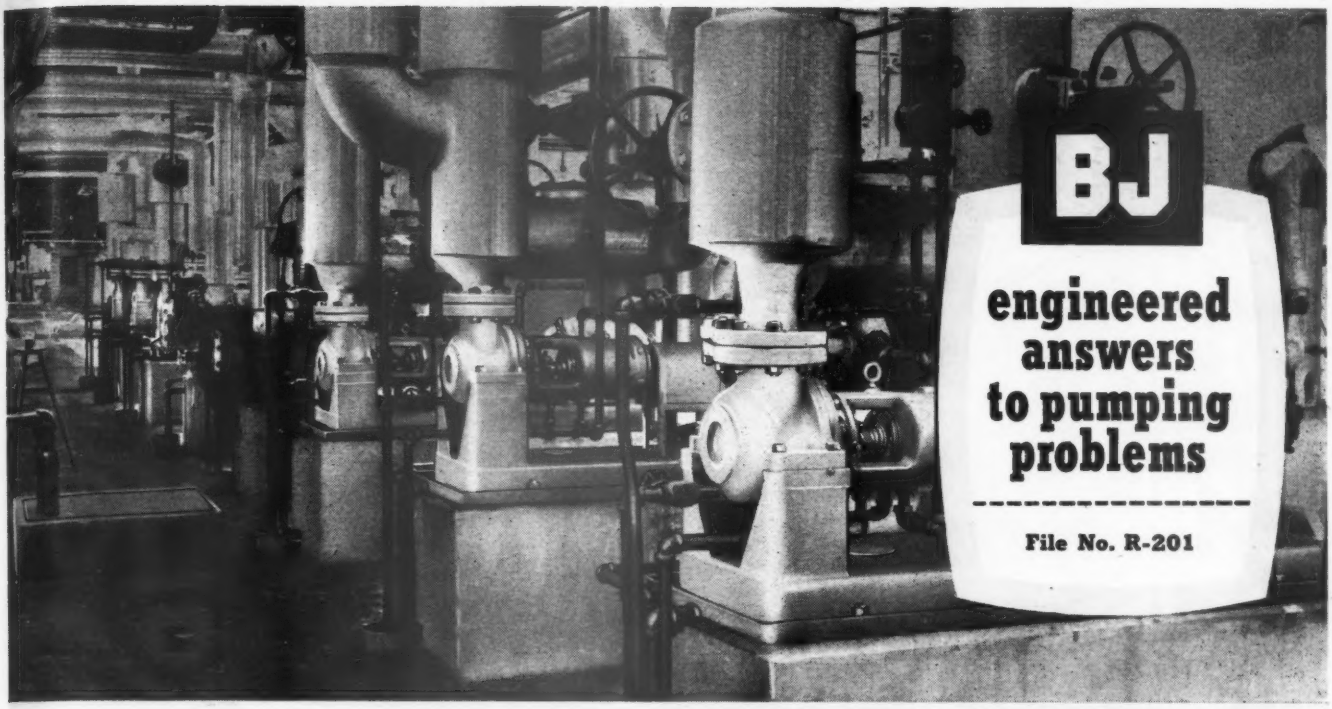

First packaged TCC Unit features 20 BJ PUMPS . . .

The world's first packaged TCC unit, recently completed at Artesia, New Mexico, is a boon to the refiner of 12,000 barrels per stream day or less. This packaged plant—including feed preparation, catalytic cracking section, fractionation, gas plant and catalytic polymerization—increases gasoline yield and improves anti-knock rating at a cost factor which compares with much larger units.

In this unique installation Byron Jackson pumps of various types and sizes are used. In fact, of the 23 centrifugals installed, 20 are BJ pumps!

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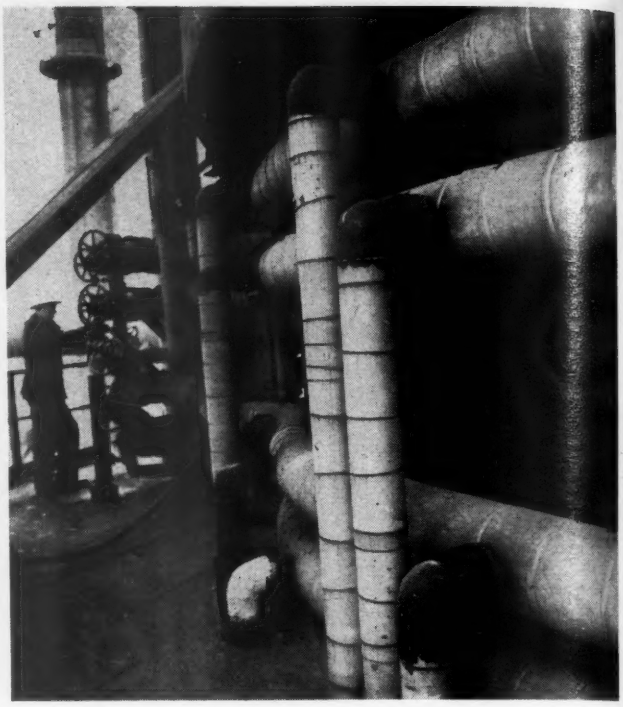
FILE FACTS:

- Designed and built by the Southwestern Engineering Co., working with Socony Vacuum Oil Co., inventors and developers of the TCC process.
- Built for the New Mexico Asphalt and Refining Co., Artesia, New Mexico.
- Fresh feed capacity—6,000 bbl. per stream day of gas oil, operating at approximately 55 per cent conversion level.

No. of Units	Type of Pump	Capacity	HP	Application and Product Handled
2	2x3x11 H Fig. 1050	215 gpm	50	Charge Pump—Handles crude oil
1	3x4x8 H SM Process	310 gpm	20	Quench Oil Pump—Handles 650°F cycle oil
5	2x3x11 L Fig. 1050	100 gpm	30	Fractionator Reflux and Absorber Charge and Stabilizer Reflux Pumps with Type "U" Mechanical Seals
1	2x3x12½ H SM Process	110 gpm	40	Flasher Bottom Pump—Handles 725°F Residuum
1	3x4x8 L SM Process	180 gpm	10	Re-boiler Oil Pump—Handles gas oil
2	1½x2x8 H SM Process	45 gpm	5	Catalytic Poly Stabilizer Reflux Pump—Handles Butanes (Pumps have Type "U" Mechanical Seals)
1	1¼ TLM Bilton	30 gpm	5	Poly Reactor Wash Pump—Handles water
2	24 KXH Vertical Circulating	6000 gpm	250 and Turbine	Cooling Tower Pumps—Handles Cooling Tower Water for entire plant (Turbine drives through Philadelphia Right-Angle Gear)
2	1½ TLM Fig. 1025	105 gpm	2	Top and bottom Absorber Intercooler Pumps—Handles light hydrocarbons (With BJ Type "U" Mechanical Seal)
1	2x3x12½ H SM Process	64 gpm	30	Recycle Pumps—Handles recycle oil
1	3x4x8 H SM Process Pump			These pumps are used as common spares for the above services.
1	2x3x12½ H SM Process Pump			

TOTAL BJ PUMPS AT REFINERY—20

Steam lines along the bottom sides of the regenerator, insulated with 85 per cent magnesia and finished with an asphalt-saturated asbestos felt jacket; at the elbows the pipe insulation is finished with asphaltic plastic.



Steam lines around the circumference of the regenerator, insulated with 85 per cent magnesia and jacketed with asphalt-saturated asbestos felt; at the elbows, the insulation is finished with asphaltic plastic.

Insulation Methods for Air-Lift TCC Unit

Tailoring insulation to fit specific conditions is a major part of efficient plant design

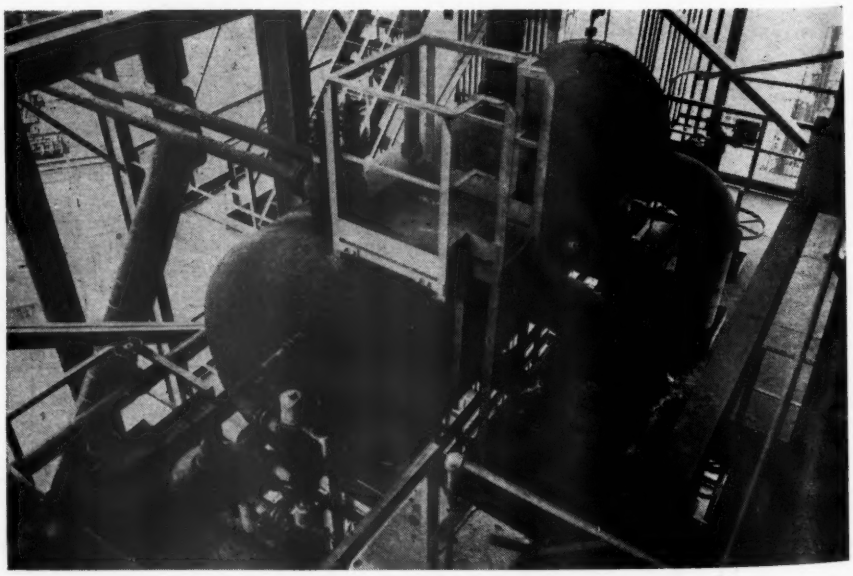
S. E. SWENSON*

RATED at 15,000 bbl per day, the new air-lift TCC unit that recently went into operation at the Sone-Fleming refinery in Brooklyn, New York, has increased the plant's catalytic cracking capacity by 5000 bbl per day. Of Socony-Vacuum design, the unit replaces an old Houdry fixed-bed cracker that had outlived its usefulness. As compared with the Houdry unit, the new unit yields a higher percentage of useful products per barrel of crude, and maintains octane levels with a saving in TEL.

To aid in efficient operation, insulation design was coordinated with the overall engineering. Because of the rigorous weather common in the area, special methods of fastening and finishing the insulation were employed. Another design consideration of interest was the specification of insulation for personnel protection where insulation would otherwise have been omitted.

*Robert A. Keasbey Company, New York.

Steam drum and piping insulated with magnesia. Drum insulation finished with asphaltic plastic; pipe insulation with an asphalt-saturated asbestos felt jacket.



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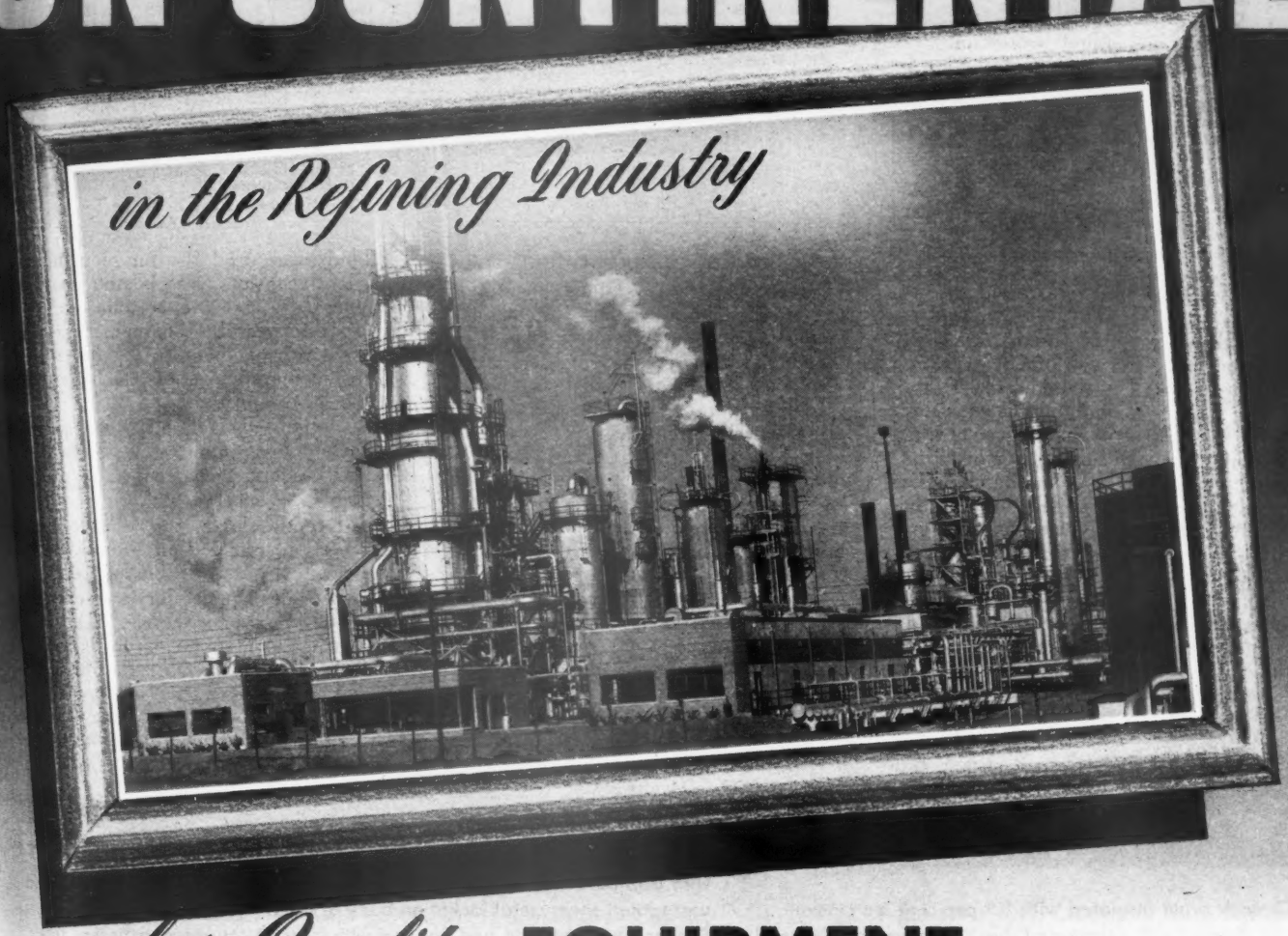

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TABLE 1. Insulation thickness for vessels, towers, exchangers, and piping over 18 in. OD

A. For heat conservation

Hot surface temperature, F	85% Magnesia (nom. in.)	Diatomaceous Silica (nom. in.)
150—300	*1½	—
300—400	*2	—
400—500	*2½	—
500—600	*3½	—
600—750	2½	1½
750—900	2	2
900—1000	2	2½
1000—1200	1½	3½

B. For personnel protection

Hot surface temperature, F	85% Magnesia (nom. in.)	Diatomaceous Silica (nom. in.)
150—300	1	—
300—400	1	—
400—500	1	—
500—600	1½	—
600—750	—	2
750—900	—	2
900—1000	1½	1½
1000—1200	1½	2½

* Thickness based on 75 Btu per sq ft per hr heat loss with 50 F still air temperature.

Insulating materials used were 85 per cent magnesia for equipment operating at temperatures up to about 600 F, and, above 600 F, a combination consisting of an inner layer of diatomaceous silica insulation and an outer layer of 85 per cent magnesia. This combination takes advantage of the resistance to high temperatures of the diatomaceous silica and the low conductivity of the 85 per cent magnesia.

Tables 1 and 2 list the insulation thicknesses used for equipment and piping, respectively. Because most of the equipment is outdoors, insulation ½ in. thicker than required on indoor equipment operating at the same temperature was specified. Insulation work was done by Robert A. Keasbey and Company.

TABLE 2. Insulation thickness for piping (nom. in.)

A. For heat conservation

	Pipe size				
Temperature, F	½—2	2½—3	4	6—8	10—16
201—250	1 85% Mag.	1 85% Mag.[1]	1 85% Mag.	1 85% Mag.	1½ 85% Mag.
251—400	1 85% Mag.	1 85% Mag.	1½ 85% Mag.	1½ 85% Mag.	1½ 85% Mag.
401—550	1½ 85% Mag.	1½ 85% Mag.	2 85% Mag.	2 85% Mag.	2½ 85% Mag.
551—800	2 Dia. Sil.	1½ Dia. Sil.[2] 1½ 85% Mag.	1½ Dia. Sil. 1½ 85% Mag.	1½ Dia. Sil. 2 85% Mag.	1½ Dia. Sil. 2 85% Mag.
801—1000	2 Dia. Sil.	1½ Dia. Sil. 2 85% Mag.	1½ Dia. Sil. 2 85% Mag.	1½ Dia. Sil. 2 85% Mag.	1½ Dia. Sil. 2 85% Mag.
1001—1200	2 Dia. Sil.	2 Dia. Sil. 1½ 85% Mag.	2 Dia. Sil. 1½ 85% Mag.	2 Dia. Sil. 2 85% Mag.	2 Dia. Sil. 2 85% Mag.

[1] 85% Magnesia
[2] Diatomaceous Silica

B. For personnel protection

Temperature range, F	Pipe size	Thickness
201—600	1½—10	1 85% Magnesia
	12 —16	1½ 85% Magnesia
600—800	1½—16	2 Diatomaceous Silica

Insulation Application

Where possible, molded insulation was applied in two layers instead of a single layer of equivalent thickness, so that a safer, more efficient installation would be obtained. Expansion and contraction of high temperature equipment often causes joints between insulation blocks or sections to open. If there is nothing to prevent it, enough heat can escape to scorch canvas around the joint. In the process area, where a leak in an oil line may develop, the heat can ignite the oil and start a fire. The staggered joint construction used with double layer insulation prevents any direct path of heat escape.

On piping 2½ in. in diameter or smaller, the insulation was secured with No. 16 gage copper clad wire; on piping of 3 in. diameter or larger, galvanized or brass Acme bands, ½ in. wide by .015 in. thick, were used.

Bands were used also for securing insulation on towers, vessels, and heat exchangers. On top and bottom heads of towers and vessels, the insulation was secured with bands or ⅛ in. cables and wiring anchored to studs or lugs tack-welded to the heads.

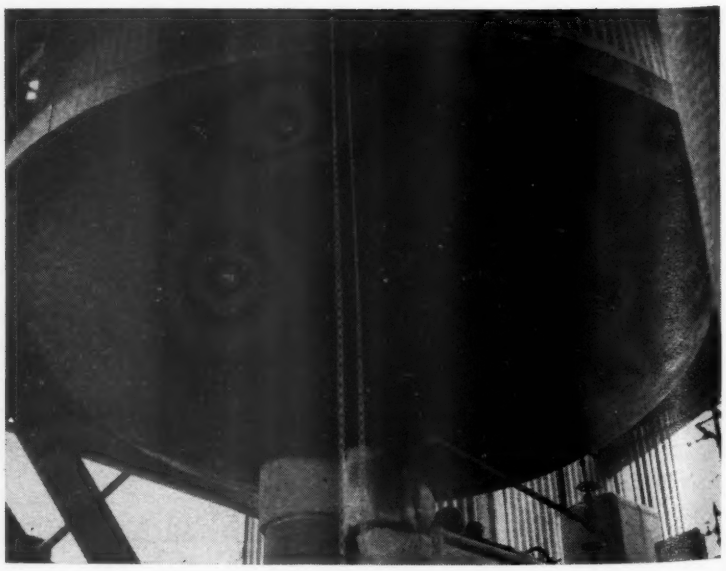
Insulation on machinery such as turbines, engines, pumps, etc., was held in place with copper clad wire and/or No. 20 gage wire mesh.

With both single and double layer construction, insulation joints were sealed with insulating cement.

To provide support for insulation on vertical towers and vessels, circumferential rings or brackets, ½ in. narrower than the thickness of insulation, were welded to the vessel shell at intervals of about 8 ft. Holes punched in the brackets served as anchor points for the bands and wires used to secure the insulation.

Quench drum insulated with 85 per cent magnesia and finished with corrugated sheet metal jacket. On head and flashing jacket is flat sheet metal.

Bottom of quench tank insulated with 85 per cent magnesia and finished with asphaltic plastic troweled over wire mesh. Note metal flashing and corrugated sheet metal jacket on body of tank. Piping is insulated with 85 per cent magnesia and finished with asphalt-saturated asbestos felt jacketing; pipe bend and flange insulation is finished with asbestos cement.



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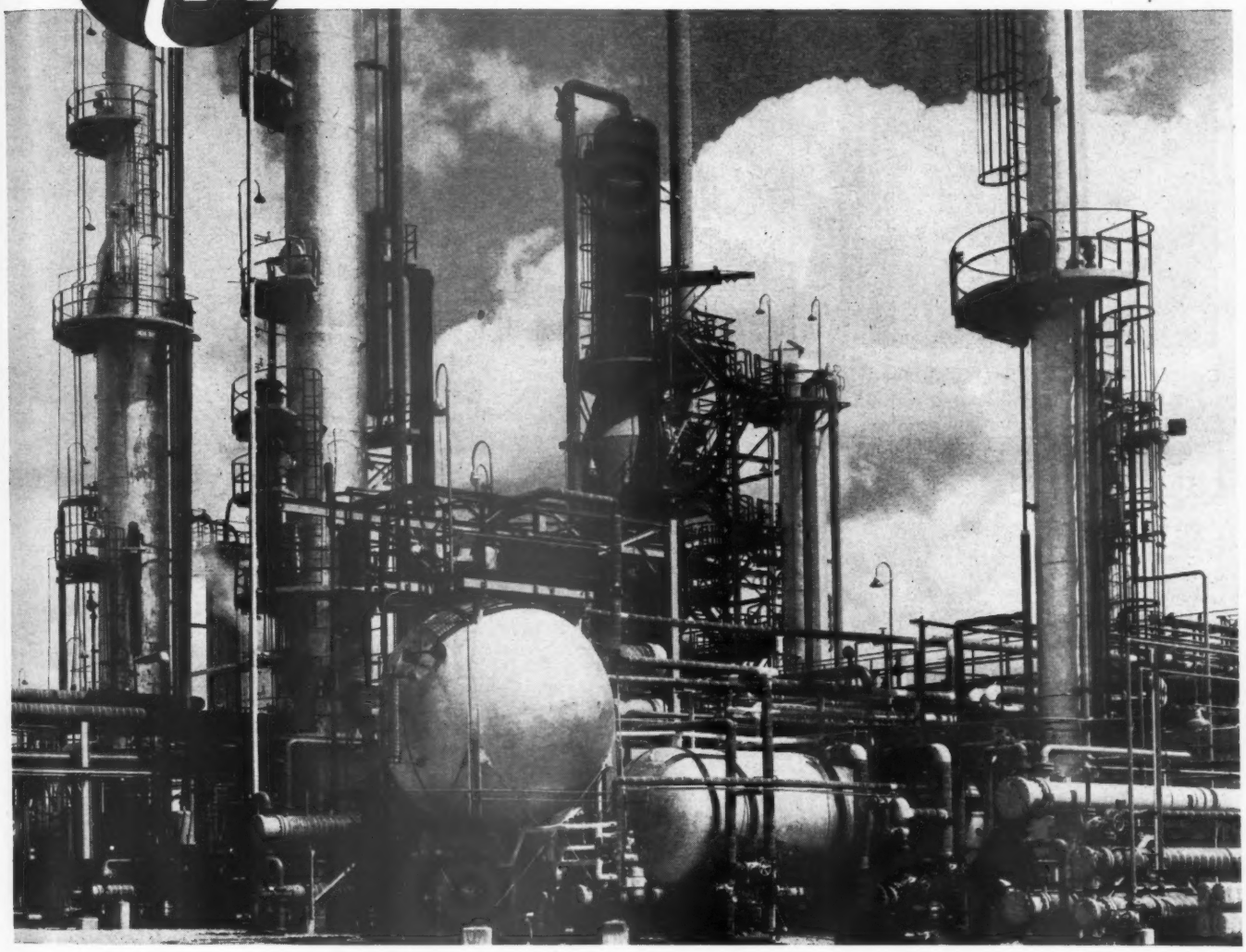

At Edmonton, Alberta, The British American Oil Company Limited has recently put into service a complete new refinery. Intended to handle production from Canada's great western oil fields, this new British American installation incorporates the most modern developments in refining technology. Like other leading refiners everywhere, British American at Edmonton relies on Petreco for desalting.

The Petreco desalter illustrated above desalts 5200 barrels per day of Redwater crude, with salt removals ranging from 94% to 96%. The electrosphere is one of Petreco's new high-efficiency, high-throughput spheres, eleven feet in diameter.

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PR 52-2

To obtain more information on products advertised see page E-51

Cyclone separator at left, separator-surge hopper at right, insulated with 85 per cent magnesia. Cyclone separator insulation is finished with asphaltic plastic troweled over wire mesh; separator-surge hopper insulation with corrugated sheet metal jacket.

Expansion joints were provided under each support in the following manner. The space between the blocks and the support above was packed with loose insulation fill. The fill was retained by a 6 in. wide, flat metal strip that was secured with a ¾ in. wide vertical band fastened at one end to the strip and at the other to the insulation band above the support bracket.

Insulation Finish

Insulation on vertical tanks and vessels and on machinery was finished with metal jackets made of copper-bearing galvanized iron sheets. Before the jackets were applied, insulation around nozzles, manways, manholes, and other projections was covered with asphaltic plastic weatherproofing. Also, openings in the jackets to provide for these projections were cut as close to size as possible, to assure a snug fit. Plastic weatherproofing acts as protection against possible water inleakage.

Insulation on horizontal tanks and vessels was finished with a double layer of asphaltic plastic weatherproofing.

On outdoor piping, insulation was finished with an asbestos felt jacket, except on fittings and valves that were finished with asphaltic plastic weatherproofing. In process areas, the felt used was of the asphalt saturated, but uncoated type; elsewhere, it was the asphalt saturated-and-coated type. On outdoor piping subject to mechanical damage, the insulation was finished with a metal jacket instead of felt.

Details of application of the various finishes on outdoor lines and equipment are given in the accompanying outline (Fig. 1).

On indoor piping, insulation was finished with an 8-oz sewed canvas jacket. Fitting and valve insulation was finished with a coat of asbestos cement mixed with Portland cement. * * *

FIG. 1. Details of application of outdoor finishes.

Metal Jackets on Vertical Tanks and Vessels of More Than 36 In. Diameter

Corrugated Sheets, No. 24 gage, applied with long dimension parallel to long dimension of vessel, longitudinal seams lapped by 2 corrugations, circumferential seams by at least 6 in.; sheets lapped downward on vertical vessels, underlap sheets being fitted with a sufficient number of "Z" or "J" clips to support overlap sheets.

Longitudinal Seams fastened with sheet metal screws, spaced 6 in. apart.

Secured with Acme galvanized or brass bands, ¾ in. wide by .02 in. thick, with double seals; bands spaced 21 in. apart, with 2 bands as near circumferential seams as possible.

Metal Jackets on Vertical Tanks and Vessels of 36 In. Diameter or Less and on Machinery

Flat Sheets, No. 24 gage, for vessels, No. 26 gage for machinery, applied with long dimension around circumference of vessel, longitudinal seams lapped at least 6 in., circumferential seams lapped at least 2 in.; where more than one sheet required to encircle vessel, sheets joined with flat locked seams; on vertical vessels, underlap sheets fitted with sufficient number of "Z" or "J" clips to support overlap sheets.

Longitudinal Seam and alternate circumferential seams fastened with sheet metal screws spaced 6 in. apart.

Secured with Acme galvanized or brass bands, ¾ in. wide by .02 in. thick, with double seals; bands spaced 12 in. apart.

Metal Jackets on Heads of All Vertical Tanks and Vessels

Flat Sheets No. 24 gage, cut into segmental caps with flashing to fit over shell jacket.

Seams of segments, standing, crimped seams.

Secured with band wrapped over flashing around shell.

Asphaltic Plastic Weatherproofing on Horizontal Tanks and Vessels

Base coat of asbestos cement, ¼ in. thick; coat of mixture of asbestos and portland cement, ¼ in. thick.

Finish coat: asphaltic plastic, ⅛ in. thick; 1 in. wire mesh stretched over plastic and laced on all edges with No. 16 gage galvanized wire; final coat of asphaltic plastic, ⅛ in. thick.

Metal Jacket on Outdoor Piping Subject to Mechanical Damage

Flat Sheets, No. 26 gage, lapped at least 2 in., with horizontal laps downward to shed water.

Circumferential seams on all lines and *longitudinal seams* on 2½ in. lines or smaller fastened with sheet metal screws.

Secured on lines of more than 2½ in. diameter with Acme galvanized or brass bands, ¾ in. wide by .02 in. thick.

Asbestos Felt Jacket on Piping

Lapped at least 2 in., with horizontal laps downward to shed water.

Secured with No. 16 gage copper clad wires on 9 in. centers, on lines of 2½ in. or smaller; with Acme galvanized or brass bands, ¾ in. wide by .02 in. thick, on larger lines.

Asphaltic Plastic Weatherproofing on Fittings and Valves

Base coat consisting of a mixture of asbestos and portland cement, ¼ in. thick, followed by 1 in. wire mesh.

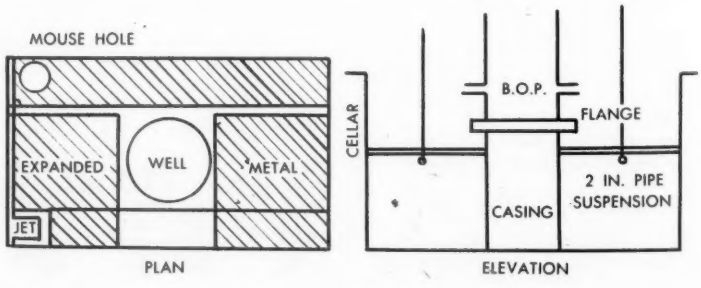
Finish coat of ¼ in. asphaltic plastic.

PLANT AID

Suspended Cellar Scaffold*

Two pieces of expanded metal, made to fit around well casing, mousehole and cellar jet are set to lie on and be supported by two pieces of two-inch pipe which extend parallel across the cellar as shown; this pipe is suspended from the sub-structure. When work is to be done in the cellar, this platform is lowered to support the workmen. When not in use in that manner, it is raised to the top to catch tools, etc., dropped into the cellar.

D. B. BOLT



*This plant aid submitted through courtesy of the Humble Oil and Refining Company's Coin-Your-Ideas Plan.

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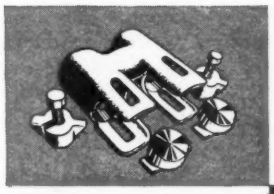

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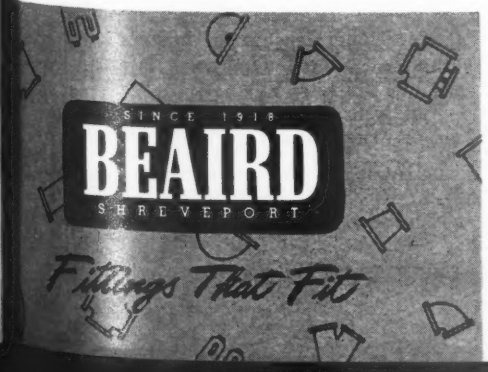

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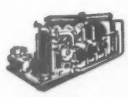

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PETROCHEMICALS FROM WATER GAS

Part 1—Advantages and drawbacks of the major production processes are discussed in this series

PETER W. SHERWOOD*

ALREADY the most important gaseous intermediate for petrochemical synthesis, water gas is today on the threshold of expansion into vast new fields.

The present petrochemical significance of water gas is primarily due to two of its products: Hydrogen (for ammonia production) and methanol. The last two years have seen the first commercial production in the United States of primary long-chain alcohols by the OXO process in which water gas figures prominently. More important yet is the production of gasoline and byproduct oxygenated chemicals from water gas by the Fischer-Tropsch process which is just now achieving commercial realization at a plant in its early operating stages at Brownsville, Texas.

In the field of fat hardening, water gas is beginning to compete effectively with other sources for the production of hydrogen. A vast chemical potential is seen for water gas in the high-pressure hydrogenation of coals and oils, already a commercial reality in some European countries. Production of isobutyl alcohol and of a mixture of "Synol" alcohols rounds out the list of major chemical uses for water gas now on the horizon.

Production Methods for Water Gas

By definition, water gas (or—in the parlance of the chemical industry — "synthesis gas") is a mixture of carbon monoxide and hydrogen, containing small amounts of nitrogen, some carbon dioxide, and various trace impurities. By production methods available to the industry today, any carbonaceous fuel may serve as satisfactory raw material for the production of this important chemical intermediate.

In many locations in the United States, natural gas constitutes by far the most inexpensive starting material for the production of water gas. Four fundamentally different processes are available for the necessary reforming step:

A. Steam reforming
1. Thermal methods
2. Catalytic methods

B. Partial combustion by means of oxygen
1. Thermal methods
2. Catalytic methods

*Chemical Engineer, Pittsburgh, Pa.

Steam-reforming methods. At suitable thermal or catalytic conditions, steam will react with methane (or higher hydrocarbons) to form carbon monoxide and hydrogen:

$$CH_4 + H_2O = CO + 3H_2 \quad . \quad . \quad . \quad (1)$$

An unavoidable byproduct of the reaction is carbon dioxide formed by interaction of steam with product carbon monoxide:

$$CO + H_2O = CO_2 + H_2 \quad . \quad . \quad . \quad (2)$$

Both reactions are strictly reversible. Equation (1) is very strongly influenced by the temperature and pressure of the system and equation (2) is substantially independent of pressure. For any given steam/methane ratio, reaction conditions will influence the product composition as follows:

High temperatures will result in — low methane content, low carbon dioxide content.

High pressures will result in—high methane content.

Fig. 1 illustrates the effect of temperature on extent of methane conversion at equilibrium using theoretical amounts of steam.

Plants requiring a very high CO/H_2 ratio find it necessary to inject CO_2 into the feed gas. CO_2 reforming of methane is in every way analogous to steam reforming except that the theoretical $CO:H_2$ ratio in the product is 1:1 instead of 1:3.

Critical consideration in reforming operations is the extent of methane reduction that determines the water gas yield. For economically permissible steam/methane ratios, the methane content of the product gas will be satisfactory for most chemical purposes (say, below 1 per cent) if the reforming reaction is carried out at temperatures above 1200 F. Actual operating temperature is always higher than this in order to obtain satisfactory reaction rates.

Steam reforming of methane is a highly endothermic reaction, 255,000 Btu being consumed per 1000 cu ft methane converted (at 1350 F). An external source of heat must therefore be made available. The usual fuel in reforming plants is natural gas. As a result, the actual water gas yield per volume of methane converted is only 1.5 to 2.8 volumes instead of the 4 volumes expected from the stoichiometry of equation (1). The actual efficiency depends on the degree of heat economy provided in the reforming plant.

The first methane-reforming plants employed purely thermal methods. Temperatures above 2000 F were required to carry out the process. The customary reaction equipment were refractory checkerwork regenators, operated cyclically by alternating between a heat-up and a reaction period. This method of reforming is conservative in its use of steam but shows low fuel efficiency and requires very high investment costs. The process is obsolete today.

A possible revival of thermal steam reforming of natural gas is seen in the development of "pebble heaters." In these units, refractory balls are circulated between a fuel chamber and a reaction space (transportation in the hot zones is effected by gravity while the cooled pebbles are conveyed by mechanical means). As flow of both fuel gases and reactants is countercurrent to the pebble flow, good thermal efficiency can be achieved. At the same time, first cost of these units is below that of regenerative heat exchangers of the same capacity. Pebble heaters[1] are therefore in a position to offer potential competition to the catalytic reforming processes, which are at present the sole industrial method for water gas production from natural gas.

Catalytic-reforming processes offer the tremendous advantage of lowering satisfactory operating temperatures to the point where the use of alloy steels is still possible (limit of industrial high-temperature steels such as 25/20 Cr-Ni is 1700-1750 F). This permits continuous operation in externally heated tubular furnaces.

Favored catalysts incorporate nickel oxide, generally on a magnesite or alumina support. Operation is carried out at 1300-1600 F.

Catalytic reforming is beset by two major drawbacks. One is the high cost

[1]A potential is also seen in the development of catalytic pebbles for methane reforming under pressure. The process bears a certain resemblance to thermofor catalytic cracking.

EXCLUSIVE

of the reaction furnace (which is, however, not so great as that of a regenerative heat exchanger or of an oxygen plant for partial combustion processes). The other is the very great sensitivity of the nickel oxide catalyst to sulfur poisoning. In sites where a sulfur-free natural gas is available, this offers no problem. If the sulfur content of the feed gas exceeds as little as .5 grains per 100 cu ft, however, catalytic operation must be preceded by a thorough purification system. Methods for removing inorganic sulfur compounds are fairly inexpensive and do not necessarily hamper the success of catalytic reforming. The presence of thiophenic sulfur or carbon sulfides (COS, CS_2) in the feed will, however, call for the use of costly purification methods, alkalized iron oxide, hypersorption, nickel oxide) which may, indeed, jeopardize the economic success of the entire operation.

Partial Combustion by Means of Oxygen. An industrial newcomer to the field of natural gas reforming is the partial combustion by means of oxygen (air combustion has been employed in some installations and will be described below). The Fischer-Tropsch plant now being put on-stream at Brownsville, Texas, will not only be the largest water gas producer in the country but it will also be the first methane-reforming plant employing tonnage oxygen (i.e., oxygen of approximately 95 per cent purity produced on a very large scale by some such process as the Linde-Frankl cycle).

The overall reaction predicts the formation of three volumes water gas per volume methane converted:

$$CH_4 + \tfrac{1}{2}O_2 = CO + 2H_2 \quad . \; . \quad (3)$$

The actual reaction mechanism seems to involve the intermediate formation of carbon dioxide and steam, which will convert residual hydrocarbon by some such reaction as indicated in equation (1). Again, the product is diluted by some carbon dioxide formed in the course of the water gas reaction (equation (2)).

Principal advantage of this mode of operation is the autothermic nature of the reaction. Although steam reforming of methane is highly endothermic, partial combustion is actually slightly exothermic and therefore independent of any external fuel source. High-temperature heat-transfer surfaces are therefore not required and reactor design becomes comparatively simple and inexpensive.

These advantages are countered by the high investment and operating costs required for oxygen production. Depending largely on plant size and local power costs, modern oxygen manufacturing processes will yield medium-purity (92-98 per cent) oxygen at a price ranging from $3.50 to $10 per net ton. The use of partial combustion processes for the manufacture of synthesis gas from methane is therefore generally limited to very large plants in low-power-cost areas. Even under the most suitable local conditions, oxygen processes are rarely competitive with steam reforming for the production of water gas as such. Only by taking account of certain contributory demand factors can partial combustion present a truly favorable picture for the conversion of methane to synthesis gas.

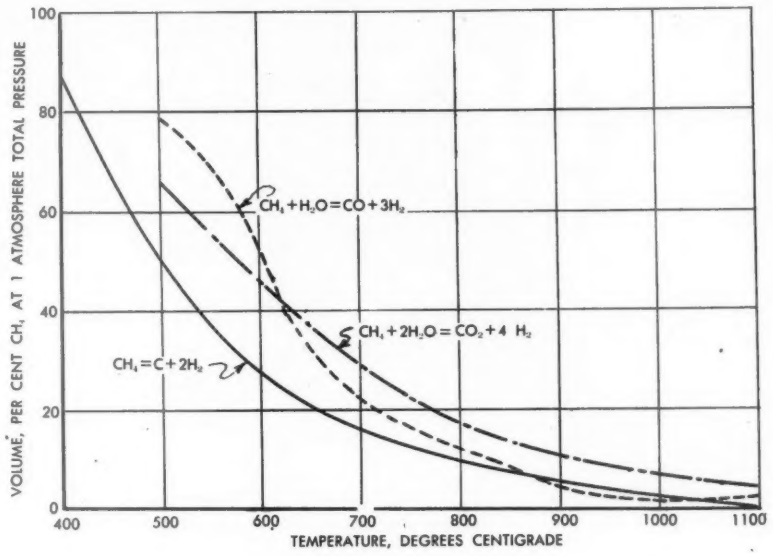


FIG. 1. Effect of temperature on reforming equilibrium.

Principal demand factors that may decide process choice in favor of partial combustion (in preference to steam reforming) are:

(1) Demand for a high $CO:H_2$ ratio in the product. It is seen from equation (3) that the make-gas may be expected to have a $CO:H_2$ ratio of 1:2, compared to a theoretical ratio of 1:3 obtained in straight steam reforming. This effect must be equalized in a straight reforming by the injection of carbon dioxide and by high-temperature operation.

(2) Conversion at elevated pressures. If the water gas is required at elevated pressures, there will be a considerable saving in compression costs if the methane conversion is carried out at demand pressure. This is due to the fact that only one volume of reactants will have to be compressed for each two volumes of make-gas (in the case of partial combustion).

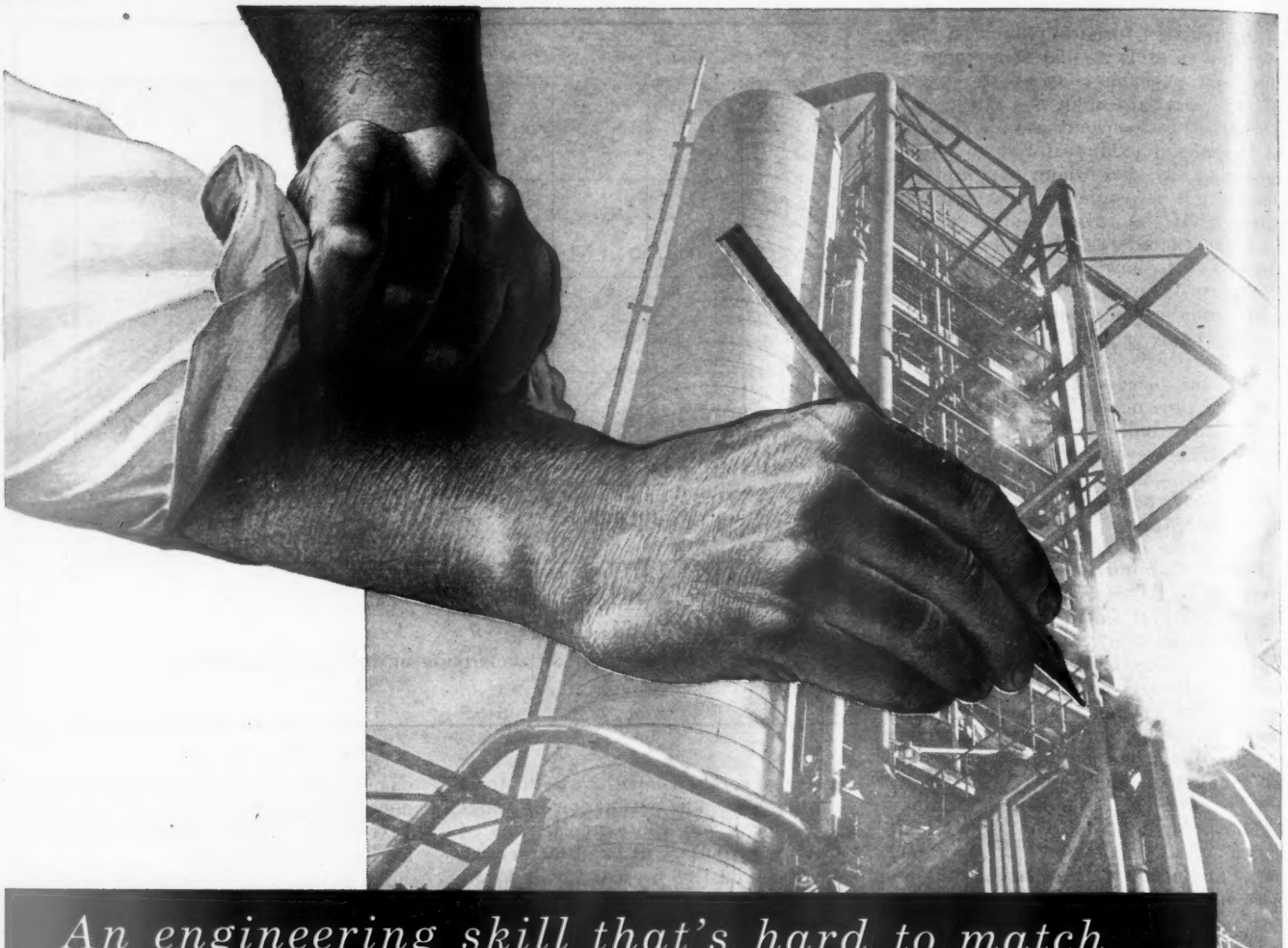
It has been pointed out above that methane conversion is affected adversely by the pressure of the system. In order to compensate for this effect, operation at higher temperatures is required. It so happens that steam reforming at atmospheric pressure already requires temperatures very near the permissible limit for high-temperature alloy steels. Pressure operation would call for temperatures which cannot be satisfactorily handled by metallic heat-exchange coils. Here operation with oxygen has the advantage that heat-transfer surfaces are not required. The entire high-temperature reaction is carried out in ceramic chambers and the system's temperature may be increased greatly with impunity (except for slightly greater oxygen and methane consumption).

As in the case of steam reforming of methane, partial combustion processes may be carried out either thermally or by catalytic methods. In both cases, the reaction is effected in two successive stages. An empty ceramic chamber is provided for the primary combustion of a portion of the methane to carbon dioxide and steam. Temperatures of 2700 F and higher are reached in the course of this stage.

Immediately following is the reforming stage in which carbon dioxide and steam react with residual methane to form the desired carbon monoxide-hydrogen mixture. This step may be carried out thermally at temperatures of 2200 F or higher, by merely providing intimate mixing over pieces of coke or broken refractories. The endothermic heat of the second (reforming) reaction stage is supplied by the sensible heat carried to this point by the combustion mixture formed in the primary oxidation stage.

Purely thermal methods of carrying out this reaction are too wasteful of oxygen to be economically feasible—except in a few isolated instances. Greater potentialities are offered by the semi-catalytic process in which the second reaction stage is carried out in the presence of a nickel-base catalyst, similar to the one described above for straight steam reforming.

In this mode of operation, the reactor exit temperature may be as low as 1450 F, with considerable resultant savings in oxygen and methane consumption. For best thermal efficiency, the incoming reactants are preheated to 1200 F by the outgoing product streams. Oxygen



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consumption is then approximately theoretical (actually about 490 cu ft per 1000 cu ft methane handled). Each volume of methane will yield 3.25 volumes of water gas containing 7 per cent carbon dioxide.

Enough steam is mixed with the feed gas to satisfy the requirements of the water gas equilibrium (equation (2)) and to suppress the formation of carbon in accordance with equation (4).

$$C + H_2O = CO + H_2 \quad . \quad . \quad . \quad . \quad (4)$$

In spite of this precaution, some soot is formed and carried out of the reaction system with the make-gas. Purification by filtration is adequate for most purposes and, if necessary may be supplemented by electrostatic precipitation.

Here again, an important requirement is the absence of sulfur from the feed gas to avoid catalyst poisoning. Presence of appreciable amounts of sulfur may necessitate the use of thermal conversion methods that cannot be carried out economically by partial combustion except in very special cases.

Partial combustion with air may be called upon to supplement steam reforming of hydrocarbons in certain instances. One example is the production of ammonia synthesis gas—a mixture of one volume nitrogen and three volumes hydrogen. Considerable savings can be effected in the manufacture of this gas by converting methane by steam reforming as well as by partial combustion with air (to introduce nitrogen). The two processes may be carried out in the same stage or in parallel. By proper adjustment of the air/steam ratio a final gas mixture can be obtained that will contain one volume nitrogen for every three volumes carbon monoxide-hydrogen mixture. Carbon monoxide can be converted to hydrogen readily by methods to be described in Part 2 of this paper.

Methods for the production of water gas from higher hydrocarbons (LP gases or various oil stocks) are mostly analogous to the two methane-reforming processes described above. One thermal steam-oil reforming process (the Jones process) has been used extensively on the West Coast for city gas production purposes. In the case of certain heavy residual oils, thermal methods of partial oxidation may be indicated, similar to the coal gasification processes to be described below.

Water Gas From Solid Fuels

At the present time, only one method is being used in the United States for the commercial manufacture of water gas from solid fuels. This process involves the intermittent gasification of incandescent fuel by means of steam. Considerable heat is consumed in the course of the gasification reaction:

$$C + H_2O = CO + H_2 \quad . \quad . \quad . \quad . \quad (5)$$

As a result the temperature of the fuel bed drops rapidly to the point where gas production rates are no longer satisfactory. The steam supply is then turned off and air is passed through the fuel bed to reheat it by partial combustion (the blow gas formed during this period is a lean mixture of carbon monoxide, carbon dioxide, and nitrogen). After the desired high temperature has once more been attained, the air blast is turned off and steam is returned to the system for another period of water gas making.

The process is simple and requires relatively low first investment costs. It has, however, serious drawbacks. For one thing, it is thermally highly inefficient. The water gas produced does not normally account for more than 60 per cent of the heating value in the solid fuel. Another major drawback is the limitation of the process to physically high-grade, non-coking fuels that alone can withstand the high blast rates necessary for high generator capacity in this cyclic process. In effect, the process is confined to the use of coke, with an occasional application of anthracite, and coke briquets, all of which are quite expensive fuels.

One way in which at least the thermal efficiency of the process can be raised is to gasify in standard water gas generators by means of oxygen and steam. In this way, exothermic reaction (6) may be made to meet the heat requirements of the highly endothermic reaction (5) without introducing nitrogen into the make gas. The process may therefore be carried out continuously.

$$C + 1/2\,O_2 = CO \quad . \quad . \quad . \quad . \quad . \quad (6)$$

This process has been used on an experimental scale at the synthetic ammonia plant of Consolidated Mining and Smelting Company at Trail, B. C. (Canada). One major American chemical producer has erected recently an oxygen plant and is carrying out this process on a commercial scale. Thermal efficiencies of 88-90 per cent have been reported for this process; this is, according to Denig (2), the highest thermal efficiency obtained in any of the known gasification processes. Principal drawback of this, as of all other oxygen-based gasification processes, is the high cost of oxygen.

Continuous Gasification Process For Solid Fuels

The severe limitations of the standard water gas process have led to the development of competitive methods, many of which are thermally more efficient and often less demanding on the physical characteristics of the fuel.

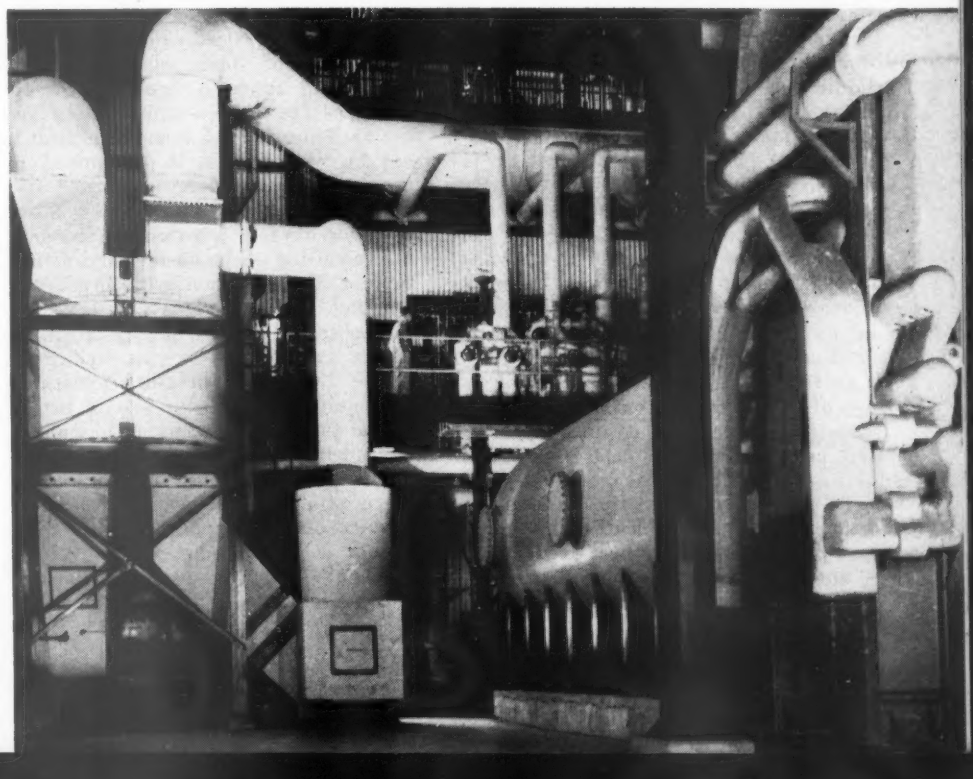
Powell (6) distinguishes three basic types of continuous gasification processes:

1. Continuous gasification with external heating.
2. Continuous gasification by recirculation of hot gases.
3. Continuous gasification by mixtures of oxygen and steam.

Representative processes of each of these fundamental types have found commercial application in European practice. Special interest has been aroused in the United States in the production of water gas by oxygen gasification of coal and at least one American installation of this type is already functioning (at Louisiana, Missouri). Experimental studies on units of type (1) are now underway at the Morgantown, West Virginia, station of the U. S. Bureau of Mines.

1. Continuous Gasification with External Heating. This process involves the steam-carbon reaction (equation (5)) in a continuously moving bed of incandescent fuel. The necessary heat of reaction is supplied through refractory walls by a (preferably inferior) gaseous fuel burned externally. Representative of this type is the Bubiag-Didier process that has been operated commer-

FIG. 2. Section of one of the methane reforming units in the synthetic ammonia plant of Lion Oil Company, El Dorado, Arkansas.



cially in Hungary and in Germany. The process requires high investment costs and considerable maintenance. Again, a non-coking fuel must be employed and thermal efficiency is not very high—about the same order of magnitude as that of standard water gas generators. Due to leakage through the heat transfer walls, the make-gas is relatively low in carbon monoxide and hydrogen content, high in inerts.

2. Continuous Gasification by Recirculation of Hot Gases. Of the numerous, basically similar processes of this type, the Koppers recycle and the Pintsch-Hillebrand units have achieved the greatest commercial success in European practice. The process involves carbonization followed by steam gasification of lump fuel in a descending solid bed. Heat of gasification is supplied by superheating the steam and some recycle make-gas in checkerwork regenerators. Heat source for the heat accumulators is some gaseous fuel. The Koppers process differs from the Pintsch-Hillebrand generator chiefly (a) in limiting recycle to *carbonization* gases, and (b) in providing recuperators as units *separate* from the gasifier.

Units of this type are limited to the use of non-coking fuels (notably lignite briquettes) and are hampered by the high investment cost of the heat accumulators. Although operation of the regenerators is intermittent, the gas generator section has the advantage of producing water gas continuously. Thermal efficiency of the unit is low, ranging about 59 per cent.

The outlook for generators of this type is improved by the recent development of pebble heaters (as described in connection with thermal reforming of methane), which may eventually be substituted for the intermittent heat accumulators now in use. This would put the entire operation on a continuous basis and may be expected to reduce first investment costs. Thermal efficiency should also be bettered by this innovation.

Another system involving the recirculation of hot gas, and invented by Schmalfeldt, was employed for the production of water gas at the synthetic liquid fuels plant at Wintershall, Germany. This process carries out the steam gasification of finely divided coal in suspension. A portion of the product gas is recycled to the gas generator after having been superheated, together with the feed steam, in recuperative heat exchangers. The process has the advantage of being applicable to a much wider variety of fuels, not being limited by considerations of physical strength or of coking characteristics. In practice, a great disadvantage has been the large loss of carbon carried out of the system with the make-gas. In its only commercial installation mechanical difficulties were severe and the process did not become successful until it was supplemented by oxygen gasification. The high cost of the recuperative heat exchangers is another major objection that may, however, be eventually overcome by engineering developments along the lines indicatd above.

3. Continuous Gasification by Means of Oxygen. As in the case of methane reforming, oxygen of medium purity (92-98 per cent) may be used for the production of carbon monoxide from carbonaceous fuels (equation (6)). The exothermic nature of this reaction obviates the need for an external source of heat. Indeed some of the excess heat of reaction may be absorbed by the simultaneous steam gasification of carbon (equation (5)).

The simplest way in which this reaction may be carried out has been described above in connection with oxygen gasification in standard water gas generators. The disadvantage of this system is that it still limits operations to non-coking fuels of fairly high physical strength.

During recent years, a number of gasification units have been developed which are designed more specifically to take advantage of the availability of relatively inexpensive tonnage oxygen. One unit of this kind has been constructed at the U. S. Bureau of Mines coal-to-oil demonstration plant at Louisiana, Missouri, and has been operating for some time.

The unit involves complete gasification of finely powdered coal in suspension, by means of oxygen and highly superheated steam. Thermal efficiency is about 70 per cent. In addition, considerable quantities of steam can be raised by cooling the very hot product gases in a waste-heat boiler.

A wide variety of solid (and liquid) fuels may be employed as raw materials. There is no limitation as to physical strength and coking characteristics. Oxygen consumption is determined by the nature of the fuel and the degree of steam superheat. A highly reactive fuel such as lignite will permit a lower gasification temperature (say 1850 F) and will therefore consume less oxygen than does more refractory bituminous coal (that may call for temperatures up to 2300 F).

The amount of heat available to the system may be raised either by boosting the degree of steam superheat or by supplying more oxygen. Both approaches are an economic burden and the optimum ratio of steam superheat to oxygen consumption is determined by economic compromise.

Disadvantage of the process is the need for oxygen. Greatest advantage is the versatility of the gasifier and its usefulness in connection with practically any fuel.

Another useful unit for the manufacture of water gas by oxygen gasification is the Lurgi high-pressure generator. This unit operates with a solid bed of fuel at pressures ranging up to 450 psi. The inherent advantage of pressure operation is the saving in compression charges if the make-gas is desired at elevated pressures. The reason for these savings is the increase in gas volume which takes place during the gasification process (equation (6)). In the Lurgi process, gas compression charges are thus reduced by nearly 50 per cent. Main disadvantage of high-pressure gas generation is the production of large amounts of methane in accordance with the thermodynamic dictates of gasification. This limits the use of Lurgi gasification to city gas production unless very high temperatures are employed in the generator. With slagging operation (i.e., at temperatures above the ash fusion point),—this is possible—at a cost in oxygen usage.

The first commercially successful oxygen-based gasification process, due to Winkler, deserves brief mention in this connection. Gasification is effected by the action of an oxygen-steam blast on a fixed fluidized ("dancing") bed of fuel. The ash is removed in part via a grate at the bottom of the generator. The remainder of the ash is carried from the system by the effluent make-gas. No provision is made for superheating the steam. As a result, high reactor temperatures can only be obtained by very large oxygen and carbon consumption. The Winkler gasifier is thus limited effectively to the use of reactive fuels that can be gasified successfully at medium temperatures (1550-1750 F). Carbon efficiency in this process is low.

A number of other oxygen-based processes, employing slagging-type generators (similar in operating principle to a blast furnace) have been employed in some localities. Units of this type have the advantage of large capacity per unit investment but they require the use of high-grade non-coking fuels and are wasteful of oxygen.

Purification of Water Gas

Purity specifications of water gas to be employed in chemical operations usually exceed the requirements of the city gas industry considerably.

The degree of freedom from the various deleterious components, which is required in the synthesis gas, depends on the nature of the chemical process and on the catalyst employed. A detailed study of the important (and often very costly) purification processes is therefore beyond the scope of the present paper and only the most generally essential and most widely practiced schemes will be considered here.

Principal impurity (from the point of view of volume) of the crude water gas

Oil Aids in Smoke Control

A petroleum-based synthetic fiber is playing an increasingly prominent part in smoke control. Filtration bags made of the acrylic fiber, when used in factory smokestacks, minimize the amounts of soot or other contaminating material which can escape into the air. Besides, the bags sift out from 10 to 15 per cent of the carbon black formerly lost, which means a cash return for the manufacturer.

is carbon dioxide. Like nitrogen, it does not have a deleterious effect on the majority of catalysts[2] employed in water-gas-consuming chemical processes. Main objection is the decrease in partial pressure of desired carbon monoxide and hydrogen with consequent reduction in reaction rates and reactor capacity. Furthermore, carbon dioxide will displace the carbon monoxide-to-hydrogen ratio from its optimum value by undergoing the water gas shift reaction

$$CO_2 + H_2 = CO + H_2O \quad . \quad . \quad . \quad (2a)$$

Methods for removing carbon dioxide from water gas are fairly well standardized. If the chemical synthesis operation is effected under pressure, it is usually most advantageous to scrub carbon dioxide from the system by means of water at elevated pressure (commonly 450 psig). This method is predicated on the availability of water at temperatures of 65-70 F or less.

Carbon dioxide removal can be carried out effectively at normal pressures by scrubbing the make-gas with an alkaline medium. In the United States, the use of regenerable ethanolamines is favored widely. Other approaches include the use of aqueous solutions of alkali bicarbonates that can also be regenerated by the application of heat. Both of these processes are effective also for the removal of other acidic impurities from water gas (notably hydrogen sulfide and sulfur dioxide).

As the carbon monoxide/hydrogen ratio of most synthesis gases must be adjusted by means of the water gas reaction (equation (2)), which generates carbon dioxide, the above scrubbing processes are usually carried out following this conversion stage. Gases that are unusually rich in hydrogen sulfide must, nevertheless, be given a preliminary alkaline wash in order to reduce the sulfur content which is deleterious to the water gas conversion catalyst (a more detailed discussion of the water gas conversion stage will be provided in Part 2).

Many of the catalysts employed in water gas-consuming chemical syntheses are readily poisoned by the presence of sulfur compounds in the gas. The bulk of inorganic sulfur can be removed by alkaline scrubbing, as described above. Residual hydrogen sulfide is satisfactorily removed by dry box (iron oxide) purification at 100-120 F or by charcoal adsorption. More expensive methods are needed for the occasionally required removal of organic sulfur components, among which thiophenic compounds, carbon disulfide, and carbon oxysulfide are the most serious purification problems. The use of activated charcoal is sometimes effective but must, in many cases, be supplemented (or supplanted) by fine purification with alkalized iron oxide at 325-520 F or by a two-step iron oxide—ZnO treatment at 750 F. Promising results have been recently reported for the removal of organic sulfur compounds from synthesis gas by means of the continuous countercurrent charcoal adsorption process, known as "hypersorption."

Other impurities which must be removed with care include gum formers (unsaturated hydrocarbons and nitric oxides) that can be removed effectively by means of activated charcoal and by oil scrubbing. The complete removal of dust and tars is essential and can usually be brought about satisfactorily by means of filtration and, if necessary, by electrostatic precipitation.

[2]Note, however, that CO_2 will poison many synthetic ammonia catalysts.

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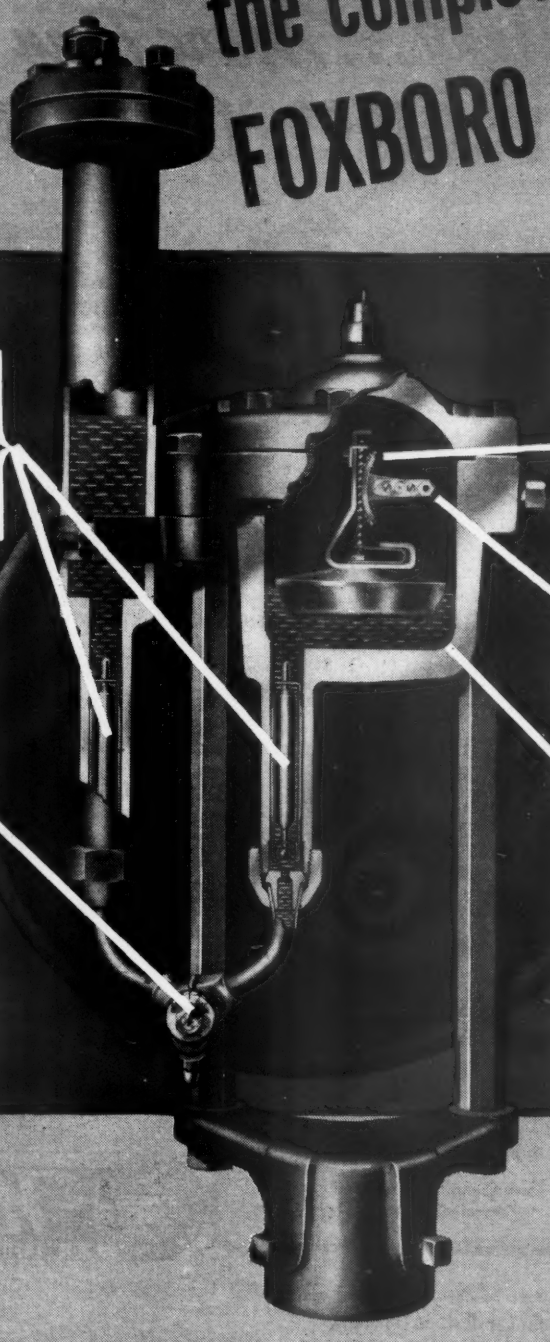

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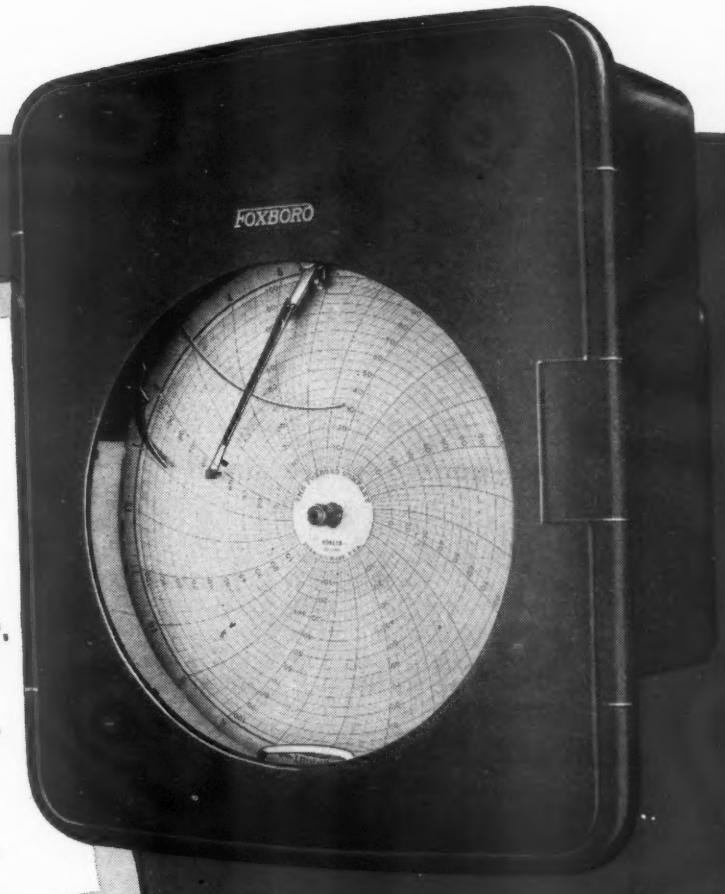

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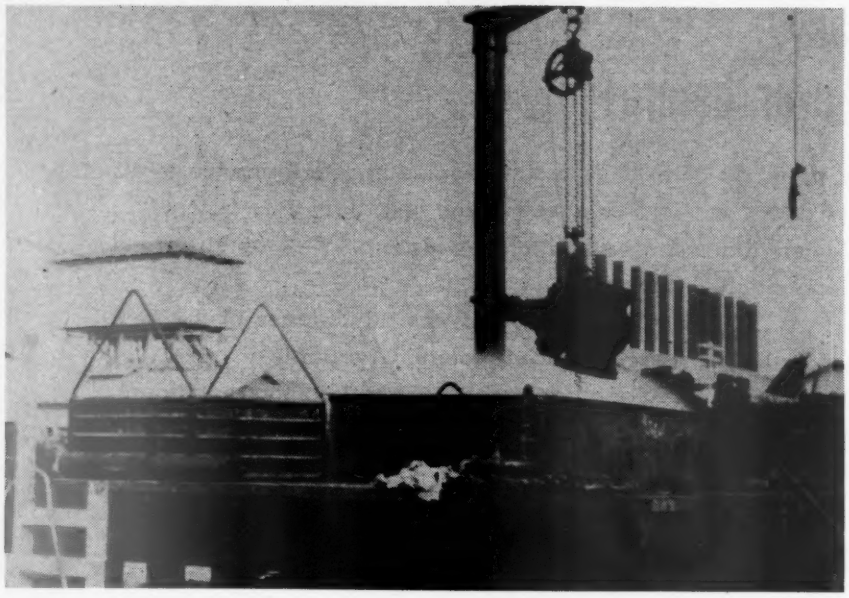

FIG. 1. Valve being lowered into salvage cleaning tank. Simplified equipment and effective cleaning solutions make short work of this job.

SALVAGE CLEANING

One way to beat the equipment shortage—methods generally are simple and economical

VINCENT E. BOWES*

In view of today's shortage of metal, you probably look on existing metal equipment for producing and refining with a more appreciative eye. You have to get more mileage out of that metal, because the day of unlimited supply is gone.

Replacement of metal parts is always a problem, however. Fortunately, one of the nearest supply sources for replacements is your scrap pile of discarded, unused parts. At least it is a partial answer. It means planning and work, but salvage work can be such a profitable part of the petroleum production picture, it is a wonder that more of it is not being done. Usable valves, pipe and pipe fittings, fishing tools, perforated casings, and rotary drills are to be found in most scrap piles. Well tools, ball wheel brakes, sucker rods, pump liners, chains, and many other types of inactive equipment may be lying around —a potential source of replacement—simply because you lack a salvage program.

Where to Start

You may find that one of the main stumbling blocks to setting up a salvage program is the lack of thorough information on the subject.

If salvage is your job, or if you make it your job, that objection can be overcome by asking manufacturers of specialized cleaning materials a few questions. The completeness of their information on the important phases of salvage work—made available to you through their representatives—is directly related to the extensive chemical research and mechanical engineering work they do in the laboratory and in the field.

This continuous research has led to the development of specialized cleaning materials for these important phases of salvage:

1. Remove grease, caked-on oil and dirt; 2. stripping paint; 3. removing rust and scale, and 4. rust prevention.

It has also led to the development of practical methods—saving considerable work — for providing these four procedures. Deciding on the right methods and the right materials, and then educating your men on the proper handling of the procedures can go a long way toward simplifying your salvage program. To repeat, it takes planning and work. That is why it will prove profitable to get the ideas and suggestions of a representative, who is thoroughly experienced with salvage procedures. That way you not only get all the ins and outs of the most practical materials and methods to use, but you also get the assurance that the recommendations are based on soundly engineered cleaning principles.

Specialized Cleaning Materials

Basically, salvage work consists of these six steps: (1) removing oil, dirt, and paint; (2) rinsing; (3) removing rust and scale; (4) rinsing; (5) neutralizing, and (6) rust prevention. Choosing specialized cleaning materials fitted to those jobs assures good results and helps you save time in both the choice and use of the materials. The main cleaning solution requirements for removal of caked-on oil, grease and dirt, and for paint stripping and scale-removal procedures shape up like this:

Oil, Grease Removal. Removing grease, caked-on oils and mud makes up a big part of salvage cleaning work. Alkaline cleaning materials (in preference to raw commercial caustics) specially designed for rapid removal of those deposits are usually recommended. They are completely safe; they clean quickly, and rinse freely. This cleaning and rinsing action leaves surfaces ready for disassembly, inspection, repair, and anti-rust treatment. Long solution life makes for economy.

Paint Stripping. Specially designed paint strippers that remove paints chemically are recommended. Pre-cleaning materials can be saved because this type of paint stripper removes both the paint and the soils at the same time.

Descaling and De-rusting. After the alkaline solutions remove the dirt and oil, any rust and scale deposits present can best be removed with an acidic type material. Solutions that can be easily controlled and are safe to personnel and inhibited against metal attack should be used.

Rust Prevention. Clean metal parts in storage or awaiting further salvage processing should be protected against rust. One of the best types to use is a specialized rust preventive that displaces the moisture and seals the metal against rust.

Preliminary Steps

Before a salvage department can function successfully, an estimate of the type and size and volume of scrap must

*Manager Petroleum Service Division, Oakite Products, Inc.

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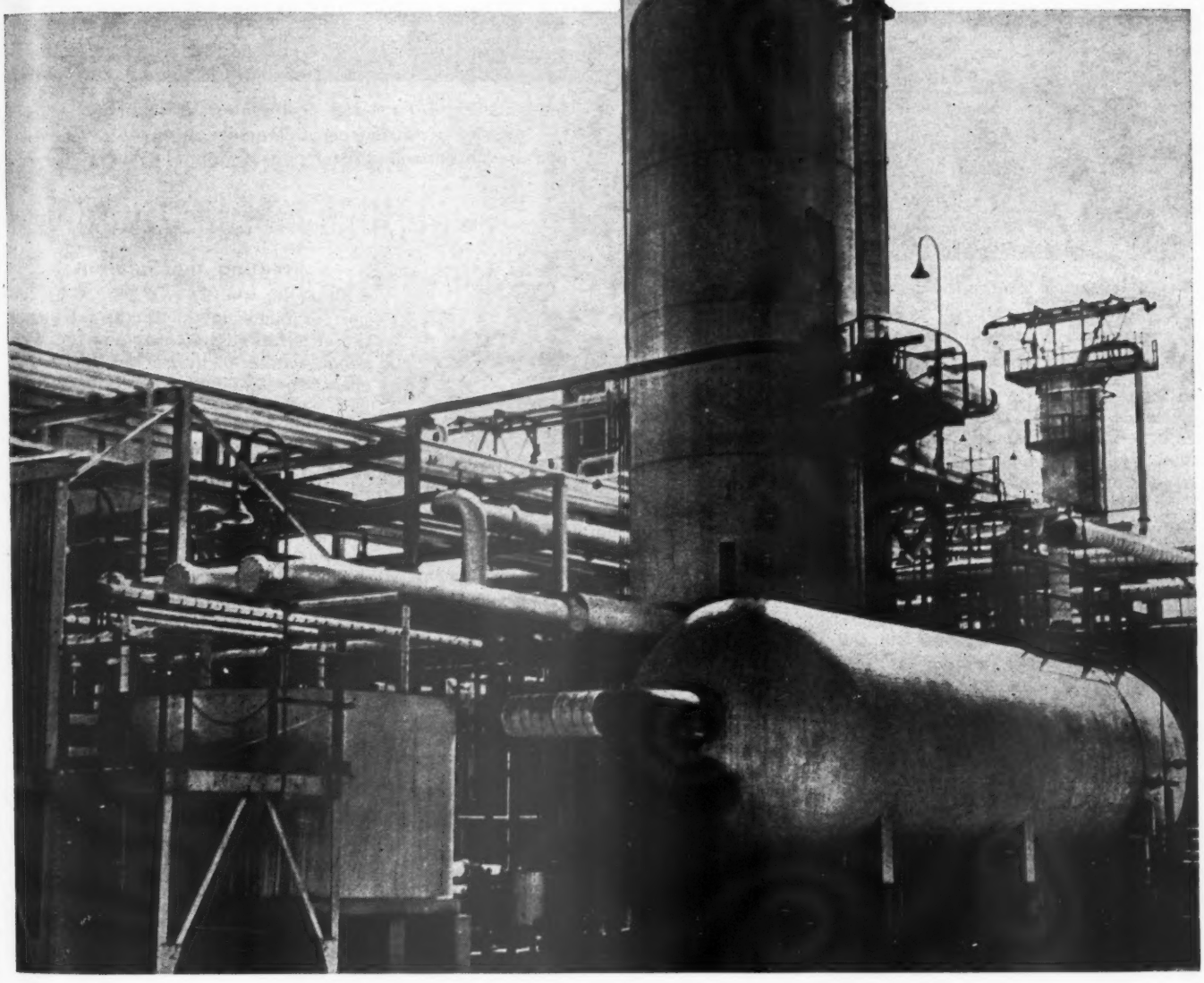

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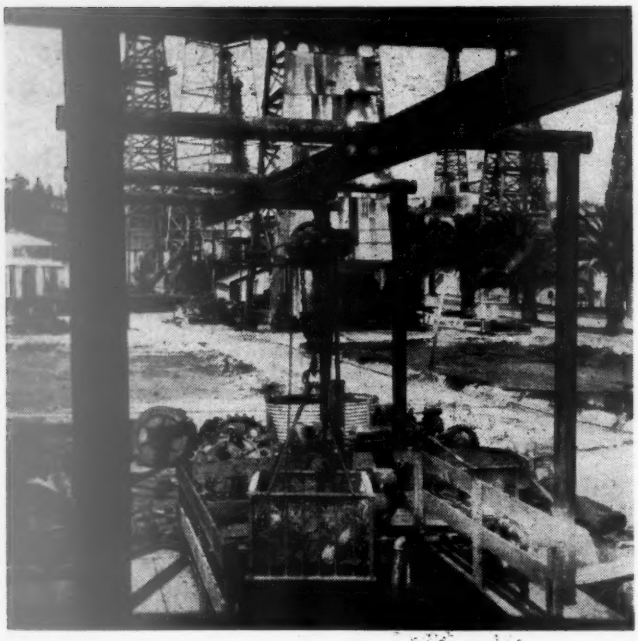

FIG. 2. Basket of small parts about to be cleaned by tank method. Repair will be easier with grease, caked-on oil, and dirt completely removed.

FIG. 3. Using a steam-detergent gun to clean parts too large for tank cleaning. Detergency, heat, and pressure provide potent cleaning force.

be made. An organized plan should be followed for sorting the various metals such as brass, copper, nickel, different grades of steel, and so forth. This preseparation simplifies the salvage program and produces better returns. It helps show you which metal to clean in which solution, because, generally, it is good practice to clean ferrous and nonferrous items separately.

FIG. 4. Close-up of modern steam-detergent gun that saves time and provides speed in salvage work on parts too large for tank work.

Methods Fit Needs

For average requirements, the tank method for removing grease, dirt, paint, scale, and rust is usually the most practical for handling the run-of-mill small parts. For larger parts, steam detergent cleaning is recommended. Details on the choice of method and the equipment needed, and procedures are given in the following paragraphs.

Equipment required for tank cleaning consists of a tank of sufficient size and capacity to hold the largest parts to be cleaned. The tank should be equipped with steam coils or other suitable heating medium to supply the necessary heat. A chain hoist to facilitate handling of parts and a means for agitating the cleaning solution should also be provided.

The solution-holding tank, the main requirement, should be large enough to accommodate the largest piece. The tank capacity depends on the volume of work and the size of the parts. For tanks up to 100 gal capacity, ⅛-in. hot rolled steel sheets should be used. For larger tanks, thicker or reinforced sheet should be used. All seams should be welded both inside and out. A tank or rinsing rack should be provided for complete removal of soils and solution by flushing with clear water.

Heating the Solution

Providing the proper heat is an important factor in the successful operation of cleaning and rinsing tanks. With good heating facilities, the speed and effectiveness of both operations can be increased.

Steam coils are recommended for heating in preference to using open steam lines, because the latter dilutes the cleaning solution, thus requiring upkeep of material to maintain proper solution strength. Steam coils should be fitted against the front side of the tank, on the side nearest the operator. In this position, no sludge forms on the coils, and the coils are less likely to be damaged by dropped parts. The steam coil should be large enough to insure violent boiling of the solution, and, thereby, greatest cleaning efficiency. It is a good idea to use a single complete unit coil so that it can be easily removed if necessary.

The overflow dam should be on the far side of the tank. That way the surge of the boiling solution will force any floating oil or dirt across the tank to the dam. This keeps clean the surface of the solution nearest the operator. A metal shield should be placed over the steam coils, to protect the coils and to increase the agitation of the boil. The shield should be perforated to facilitate the agitation.

Cleaning Procedure

To remove oil, grease, sludge and muck deposits, the tank should be charged with a solution of a suitable heavy-duty alkaline cleaning material referred to earlier in this article. With the choice of the right material, comes the question of the concentration at which it should be used for the most efficient results.

For average salvage work, the concentration generally ranges from 4 to 8 oz. per gallon, of water. After the solution is brought to a temperature varying from 180 F to 212 F, parts are immersed in the tank. The immersion time de-

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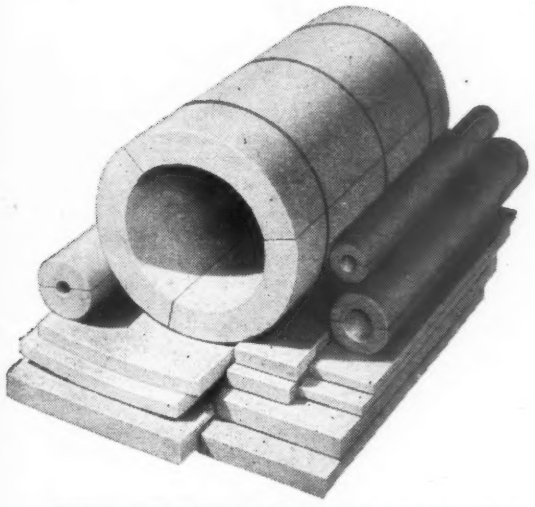

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pends on the amount and type of soils being removed and the speed of cleaning desired. If conditions are adjusted for maximum cleaning effectiveness, soil accumulations are completely removed in a short soaking time. Heavy soils are either completely removed or softened and loosened so that they can be easily removed by pressure rinsing. Parts are then ready for inspection and repair, or for repainting and storage for further use.

Removing Rust and Scale

If there is any rust and scale on the parts, it will be apparent after the oil, grease, muck, and dirt deposits have been removed. Removing rust and scale requires immersion in another tank—constructed with suitable acid-proof lining—containing an inhibited acid bath. If the rust deposits are light, they can be removed by applying the de-rusting solution with a brush. Either way, the acidic treatment should be followed by thorough rinsing and the application of a weak alkaline solution to neutralize any acid remaining in the pores of the metal. A final rinse completes the operation.

Because of the uncertainty of uniform results and handling hazards involved, the use of raw commercial acids for this work is diminishing. These factors also account for the concerted research that has been done in the development of inhibited acidic materials. Compounds of this type provide effective yet controlled descaling action. This results in new standards of safety and uniformity of scale and rust removal.

Steam-Detergent Cleaning

When parts to be salvaged are too large for cleaning by tank, the steam-detergent cleaning method should be used. In this method, a high-velocity spray of steam and a suitable cleaning solution is projected through a steam gun. This brings to the soiled surfaces a scientifically balanced combination of heat, mechanical force, and effective detergent action to loosen and remove even heavy, caked-on oil, grease, and dirt. Fig. 4 illustrates a specially engineered steam gun that is widely used today for steam detergent work.

The use of steam-detergent cleaning in connection with salvage as well as in regular equipment maintenance or periodical repair is not new practice in the petroleum industry. It has found wide use for many years because it is a fast method of cleaning large parts without tedious scraping and scrubbing.

Now it is being more widely used than ever, because improvements have been made during the last few years so that auxiliary apparatus such as pumps, motors, injectors, or pressure solution supply tanks are not necessary. One type of gun available for salvage work in the petroleum field is highly recommended because it lends itself to a simple installation. It is light weight and is easy to use. With its special "solution lifting" feature, this gun can lift the cleaning solution from a metal drum or container to a working height of 12 ft without the aid of the accessory apparatus previously required for steam-detergent cleaning.

All that is necessary to operate such a unit is a steam supply of 30-lb pressure or more, hoses for steam and cleaning solution, and a metal drum or tank to hold the solution. No motors, pumps, etc., are required. This type of gun can be used wherever a steam line is within reach.

Clean Parts Make Inspection Easy

Your salvage work may require only one cleaning operation to remove soils; or it may require an additional operation in which scale and rust must be removed. After these operations, the part may be in condition for re-use. If not, it will be effectively cleaned so that inspection can be carried out to discover the damage that needs repair. Further work, whether it be repairing broken areas, or building up worn areas through welding, metal spraying or plating is dependent on dirt-free film-free working surfaces. When the cleaning has been properly done in the first place, no time will be wasted between the cleaning and subsequent steps in your salvage program. Undue delay after cleaning and before subsequent salvage operations will enable rust to develop and new foreign deposits to settle.

Rust Prevention

It is one thing to clean metal parts, but another to keep them clean during salvage operations or during storage. Rust is the greatest difficulty once you get the metal parts clean. That is why it usually pays in the long run to use a rust preventive after cleaning if the parts are not to be inspected and repaired immediately, and if the parts do not need repair but are simply to be put in replacement storage.

Many plants make provision for an anti-rusting operation to be included at the end of the cleaning work. A tank containing a specially designed rust-retardant is situated so that cleaned parts go into it directly after thorough rinsing. A rust preventive that displaces the moisture and seals the metal against average indoor rusting conditions should be used.

Conclusion

The main types of work discussed and illustrated in this article include all the various cleaning operations that might be performed in the average refinery. In broad outline, it indicates what can be done to set up a simplified salvage program through the use of modern specialized cleaning materials and points out the value of such a program. If all that is needed is the basic information to get started, or if some problem is hampering good salvage procedures in the plant, remember there is plenty of information about salvage available through representatives of cleaning materials manufacturers. * *

Freeport to Use Sea Water

Freeport Sulphur Company has announced a new process for using sea water in mining its new sulfur deposit at Bay Ste. Elaine, in Louisiana. There are no sources of fresh water near Freeport's new deposit, and engineers devised a method of passing the sea water through packing and treating it with flue gases from the steam boilers, removing most of the oxygen present in the water. The deposit is mostly underwater, and Freeport expects to erect its plant on a large barge.

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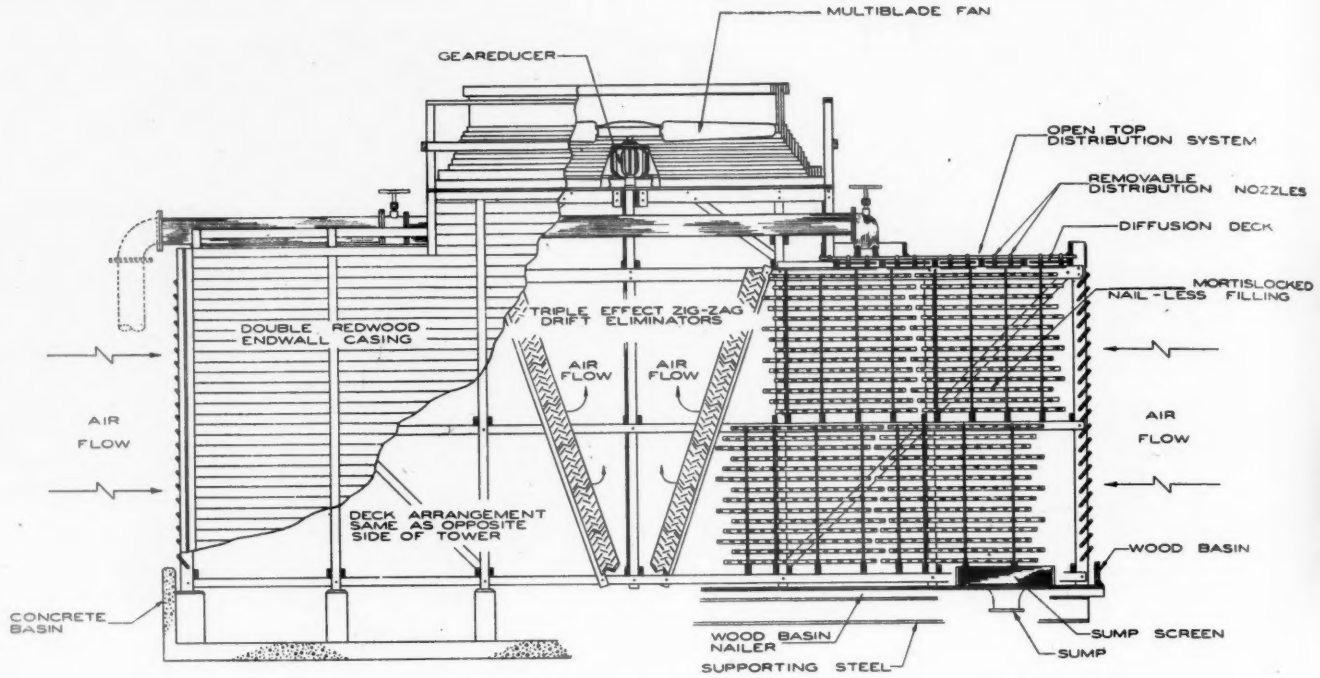

Large capacity crossflow tower; note open top distribution system, full height louver opening and large drift eliminator area.

COOLING TOWER MAINTENANCE

Detailed inspection and repair of a cooling tower, after shutdown, give long life and lower operating costs

HOWARD E. DEGLER*

WELL maintained (clean) equipment gives the best operating results and the least maintenance cost, this is especially true for cooling towers. A daily general inspection should be sufficient; a regular inspection schedule of the mechanical equipment and structure should be set up to insure continuous effective operation. There are three important water problems in operating a cooling tower: (1) Protect metals against scale and corrosion; (2) the control of algae and slime; and (3) the protection of the wood. A complete chemical analysis of the water should be used as the original approach to water treatment problems.

Tower Materials

The choice of cooling tower materials and equipment is an important maintenance factor. Selective purchase to definite specifications is recommended; quality should be the criterion, not price.

The materials used in cooling towers are exposed to an atmosphere of warm, humid air, and a complete range of moisture conditions varying from water-flooded to completely dry. The temperature range is moderate but it includes growing conditions for wood-destroying organisms. The remarkable durability of redwood makes its use desirable for cooling tower construction.

The use of non-corrosive metals or protective finishes is generally in evidence on cooling towers. Copper nails, bronze or galvanized bolts, aluminum, monel or stainless steel fan blades, protective coatings on castings and steel surfaces, weather-proof motors and switches, elimination of/or minimized lubrication, sturdy spiral bevel or hypoid gear speed-reduction units, and other trouble-free features should be a part of every industrial cooling tower selected for minimum care and maintenance.

EXCLUSIVE

Pre-Starting

Cleaning. When a cooling tower is begun for the first time, or after a long shutdown period, it should be thoroughly cleaned and inspected. Remove all dirt and trash that has accumulated in the hot or cold water basin, or on the air inlet louvers. See that nozzles or orifices in hot water basin are open. Remove any debris from suction screen and sump.

Inspecting. Check the fan for free rotation, ample tip clearance, and proper direction of rotation. Usually, fan must rotate clockwise when viewed from above. Directional arrows on blades of some fans show proper rotation. Clearance between the ends of blades and the cylinder should be approxi-

*Technical Director, The Marley Company, Inc.

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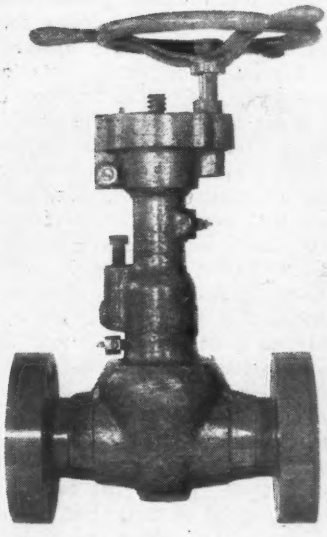

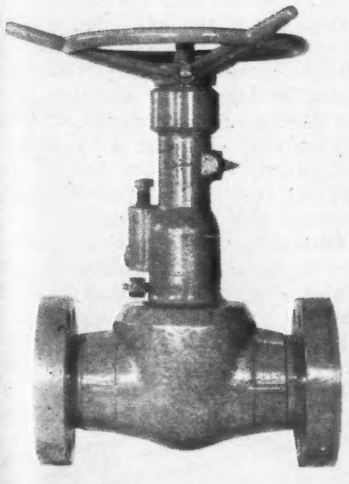

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mately one per cent of the fan diameter. Fan hub cover (if provided) must be fastened tightly to fan hub.

Check oil level in gear reduction unit. If necessary, add oil per manufacturer's instructions. Check motor insulation with a "Megger". It may be advisable to bake (dry out) or revarnish the winding. Check electric motor lubrication per motor manufacturer's instructions.

Tighten fan assembly bolts as required, particularly those in connection with motor, drive shaft, gear speed-reduction unit, fan, and fan cylinder. Check free operation of float valve or functioning of make-up water supply. Close access door, if provided.

Starting

Fill the cold water collecting basin and connecting pipe system with water until the operating level is reached, about 6 in. or as recommended by manufacturer. The float valve, if used, should be adjusted to maintain water at the required level.

Be sure that all valves are open, then prime and start the circulating water pump. Equalize water distribution between cells (if more than one cell) so that all cells are receiving like amounts of water by valve adjustment.

Water Discoloration. Redwood contains certain materials that provide its distinctive color and properties that resist decay. The most soluble of these materials are dissolved by the circulating water when a cooling tower is first placed in operation. The discoloration is due to the tannins in the wood. The durability of the wood is not reduced appreciably by the removal of these soluble tannins. A low pH (below 7.5) of the water is desirable to prevent possible leaching and resultant lowering of the wood durability.

The water discoloration will disappear within several months usage; its presence in most circulating systems is actually beneficial, and changing of the water is not necessary unless the color is objectionable. Tannin is a surface-active agent that prevents the formation of scale. Water discoloration may be reduced by adding an oxidizing agent such as chlorine, since the tannins are powerful deoxidants.

Starting the Fan. Usually, fan must run clockwise when viewed from above. If the fan operates with considerable vibration, refer to Tower Trouble Tips on last page of this article. Vibration generally decreases when tower has operated for a day (after soaking wood).

Operation

Hot-Water Distribution System. Maintain a uniform water distribution at the orifices or nozzles (uniform spray height and cone). The amount of water circulated should approximate the contract requirements, and the nozzle pressure should be kept between 1¾ and 2 lb (6½ and 7 psi on spray-filled towers). Lower pressures may indicate excessive losses in piping system and/or insufficient pump capacity; greater pressures might indicate clogged nozzles or over-pumping. If a greatly reduced water flow is desired it may be advisable to change nozzle sizes (or plug some) to obtain the desired pressure and good water distribution.

Cold-Water Collecting Basin. Normal operating water level in a wood or steel basin is 6 to 9 in. above the base of the column; depth for a concrete basin is dependent on suction arrangement used. Enough depth must be maintained to keep pump from pulling air into the line.

Make-Up and Blow-Down. The amount of "make-up" water that is required to keep the water in the water collecting basin at the required depth, depends upon the "Evaporation loss", "drift loss", and "blow-down". Water for make-up averages 1½ per cent of the water circulated for a cooling range of 10 F. Drift is negligible in most towers; clogged nozzles and over-pumping cause drift.

The amount of blow-down, also called run-off, depends primarily upon the hardness of the water and the type of water treatment used. Too high a concentration of dissolved solids in the circulating water may cause sludge deposits in the system or corrosion of metals. Concentration of solids is generally controlled by the continuous or intermittent removal of part of the circulating water. A small bleeder line from the hot water supply pipe, or a continuous overflow from the water-collecting basin may be used for this purpose. For best results, a competent water chemist should be consulted.

Winter Operation. Extremely cold water normally does not increase performance very much, but operating hazards are increased considerably. Cooling towers operated in freezing weather are subject to ice formation at the air inlets; small amounts of water are likely to freeze on the inlet louvers and the nearby wood filling. Ice starts to form on the lower section of louvers and progresses upwards; this accumulation of ice restricts the inlet area and reduces the air flow, thus increasing the temperature of the water being circulated through the tower.

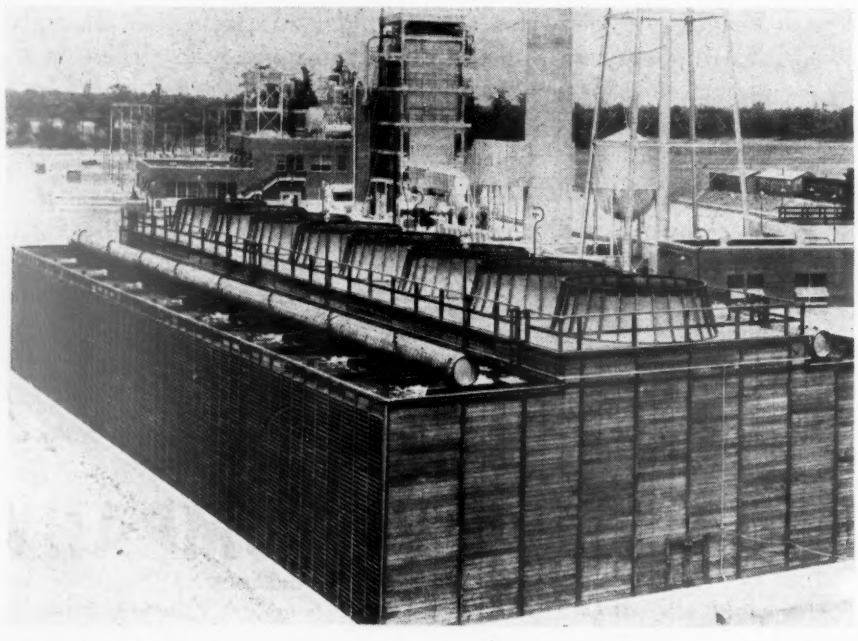
The main mass of the tower circulating water is rarely cooled to a temperature that even approaches freezing; in fact the cold water temperature will seldom be lower than 60 F, except with towers used for specific operating conditions. For this reason, ice will form only on parts of the tower that are lightly wetted by fine drops which splash toward the entering air stream.

To prevent icing during cold weather operation, one or more of the following procedures are recommended for induced-draft towers: (a) Shut down or reduce speed of fans, but do not shut off water; (b) cover upper portion of louvered area with canvas; and/or (c) shut off some of the cells.

If ice should form on the louvers and filling, one of the following methods of removal could be used: (a) Reversing (for a limited time) the rotation of the motor driving the fan and thus blowing the warm air backwards and out through the louvers; (b) shut down some fans temporarily but do not shut off water; and/or (c) cover upper portion of louvered area with canvas.

Intermittent Operation. When the unit is operated intermittently during winter weather, it is necessary that the water be drained from the exposed piping to insure protection against freezing and possible rupture. Basin drains should be left open during winter shutdown periods to allow rain and melted snow to escape.

Eight-cell crossflow tower with 30 in. diam redwood hot-water piping; note lights, water in top basin, and access doors at bottom of front end wall. Unit below cools 30,000 gpm of water from 105 to 90 F with a 76 F wet bulb of air.



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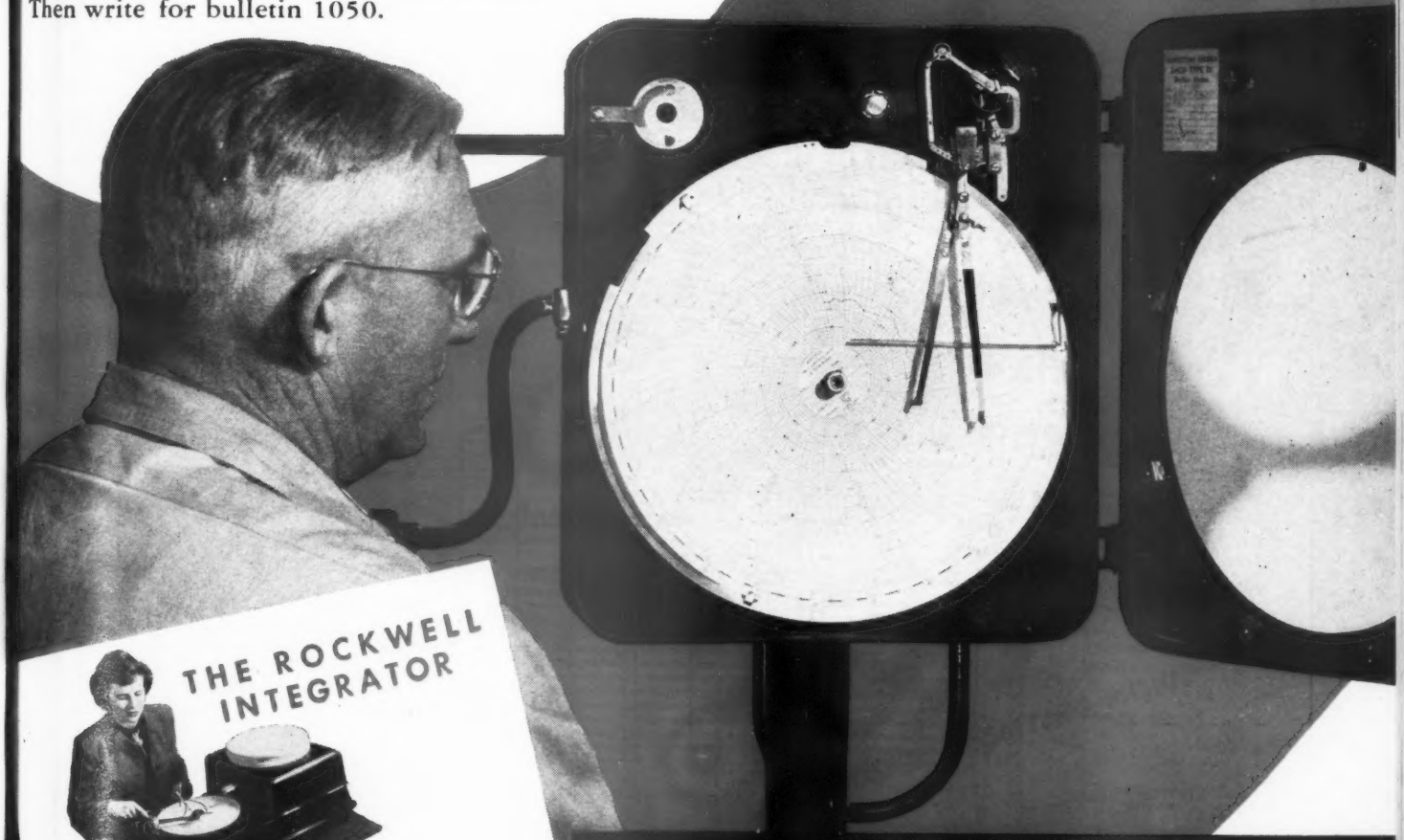

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Unit Maintenance

Well maintained (clean) equipment gives the best operating results and the least maintenance cost. It is recommended that a regular inspection schedule be set up to insure effective operation of the cooling tower. In most cases a daily general inspection should be sufficient.

Hot-Water Distribution System. Keep the distribution system (piping and nozzles) clean and free of dirt, bugs, slime, algae, and scale. Algae and scale may clog nozzles, eliminators, and piping; and may collect on the equipment served, thus reducing its performance.

Cold-Water Collecting Basin. Inspect redwood basins occasionally and recaulk when necessary. Minor leaks may appear when starting with a dry basin but they will generally disappear after the wood becomes soaked. Tighten bolts in wood basins after shutdown when wood is dry. Cold water outlets should be kept clean and free of debris. Float valves or water inlet controls, if used, should operate freely and maintain the proper water level.

Tower Framework. Keep framework bolts tight. Bolts in the framework supporting the mechanical equipment at the top should receive particular attention.

Drift Eliminators. Eliminators should be kept clean. The top line of slats must direct the air toward the center of the fan. Do not leave open spaces between eliminator bundles or between these bundles and side walls as that would allow excessive drift; keep closure strips, provided for these spaces, in place.

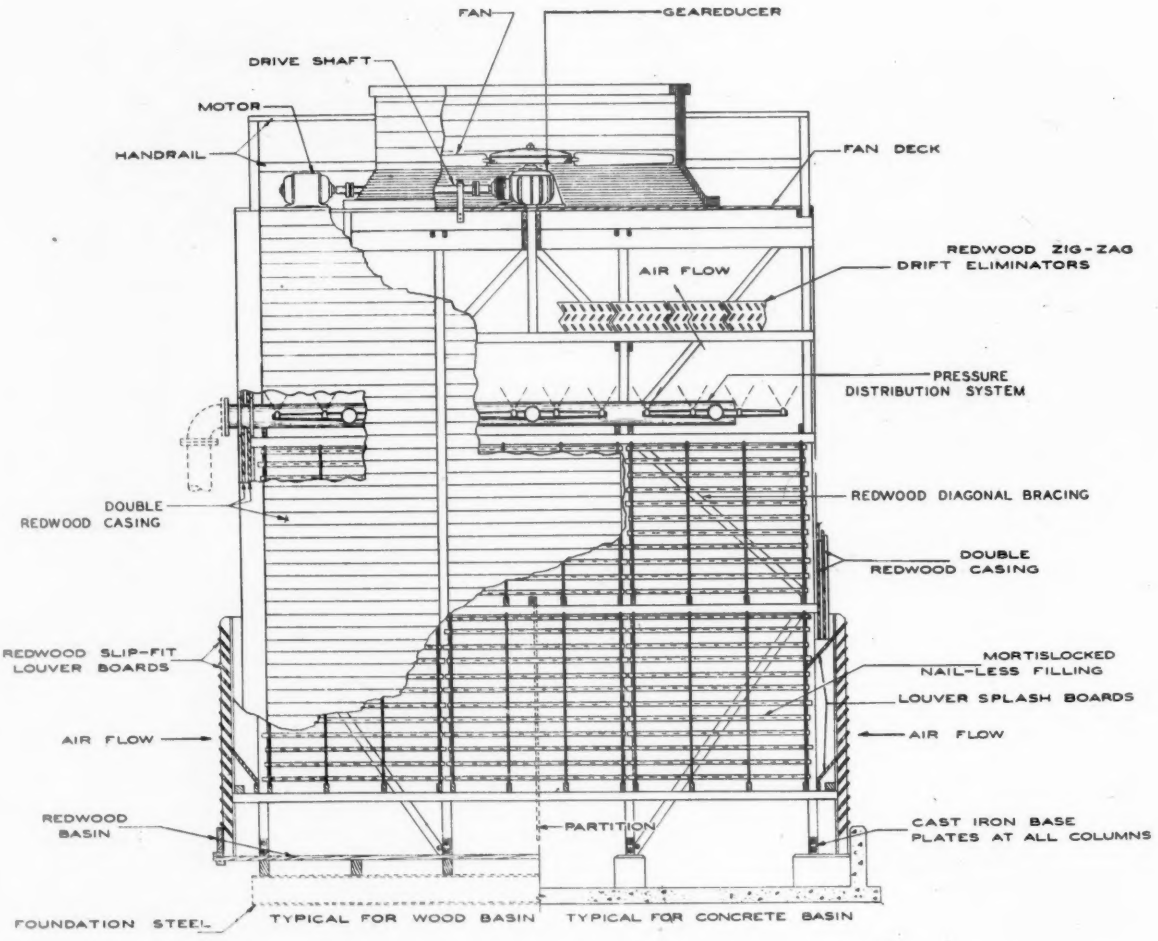
Electric Motor. The lubrication and maintenance of each electric motor should be in accordance with the manufacturer's instructions. If repair work is necessary, contact nearest representative of the motor manufacturer.

A motor in continuous operation will stay at a temperature sufficiently above ambient temperature to prevent condensation of moisture on and about the windings, even if the location is very humid. Idle motors, however, accumulate moisture readily, which causes gradual deterioration of insulation. Where motors are idle for a long time, single-phase heating, or small space heaters might be necessary to prevent water condensation. Presence of water in totally enclosed motors quite often indicates leakage at shield points, handhole covers, lead entrances, etc. Such leakage may be avoided by use of sealing compounds.

Proper lubrication is essential to long life of a motor, but do not overlubricate. Use low pressure air at intervals to remove dust from windings. Misalignment of connected load may occur, a hot bearing may be an indication. Vibration is undesirable, tighten the motor mounting and check bearings. Disconnect driven load to determine if vibration is in motor. Also make certain that the motor is not overloaded, check amperes required with nameplate.

Drive Shaft. The drive shaft may become unbalanced in operation causing vibration. This may readily be corrected by balancing as described in tower manufacturer's instruction bulletin. Some drive shafts require no lubrication, others require lubrication with a semi-fluid universal joint grease after each 500 hr of service. Inspection of the complete drive shaft should be made at least every six months. Look for corrosion, loose bolts, worn parts, and for excessive misalignment (not more than 2½ deg). Repair or replace as necessary.

Gear Speed-Reduction Unit. The speed-reduction unit, right-angle gear



Induced-draft counterflow cooling tower; note rugged simplified mechanical equipment.

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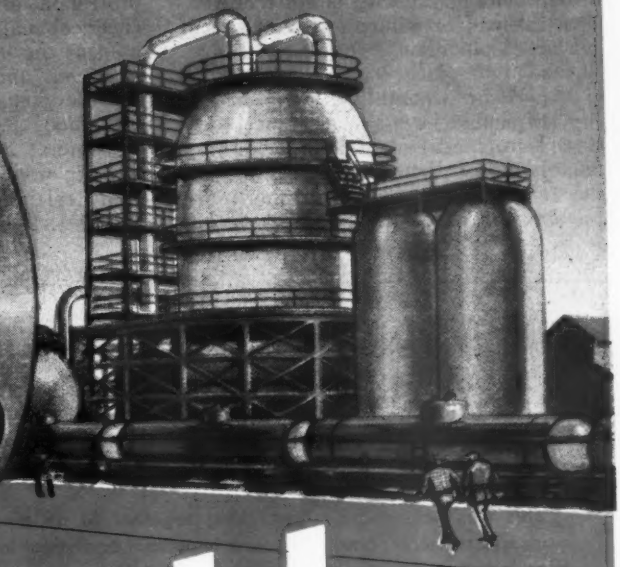
But you can be right the first time with Powell Valves because they're designed to meet specific flow control conditions.

There are more *specifically adapted* Powell Valves in use today than any other make.

The Wm. Powell Company
Cincinnati 22, Ohio

Fig. 2491.—Stainless Steel O. S. & Y. Gate Valve for 150 pounds W. P. Available in a variety of other corrosion-resisting metals and alloys. Also made with screwed ends.



POWELL

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DEPENDABLE VALVES SINCE 1846

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drive on which the fan is mounted, is one of the important parts of the tower-fan unit. The manufacturer's nameplate affixed to the side of the speed reducer generally provide lubrication and other pertinent instructions. The oil level should be inspected at least monthly when in continuous service. Change oil after a maximum of 3000 hr operation or at least once every six months (summer and winter). Refill with a high grade mineral turbine type oil or a high grade multi-purpose gear lubricant. Oil seals at pinion shaft and fan shaft are provided and should be inspected for leaks at least semi-yearly.

Check all assembly bolts and cap screws for tightness and make certain that the vent on the unit is open. A clogged vent may cause premature failure of the pinion shaft oil-seal resulting in oil leakage. New speed-reduction units should be operated at reduced speed for a day or two whenever possible before starting operation at full speed and continuous duty. The original lubricating oil should be replaced with new oil after the first week of operation.

Fan. The cooling capacity of a tower is primarily dependent upon the quantity of air moved through the unit by the fan, hence the design cooling capacity is obtained when the fan-motor is operating at the contract horsepower for a definite fan blade pitch setting. If the design cooling capacity is not required (partial load or winter operation), the fan blade pitch may be reduced to save power.

A periodic (monthly) inspection of the fan should be made to assure continued trouble-free operation. Any accumulation of dirt or scale deposits on the fan should be carefully and completely removed to maintain accurate balance. Preventive maintenance to control corrosive attack will prolong the useful life of the fan.

If one or more blades are replaced in a multiblade fan, the complete wheel should be rebalanced in the field. By providing a shaft through the center bore of the hub, the wheel may be suspended in a vertical plane with level knife edges under the ends of the supporting shaft. Then by adding weights to the hub or blades until all tendency to rotate is removed, a satisfactory field balance may be obtained.

Painting. All metal parts subject to corrosion should be cleaned and painted periodically. Steel surfaces should be wire-brushed and chemically cleaned. A zinc chromate primer coat should be used with a finish coat of aluminum or an air-dry enamel. A baked enamel finish can be used on aluminum fan blades to secure a durable film surface and corrosion resistance to alkaline waters.

Redwood does not require protection from the weather; however, in some cases it may be painted for appearance. Any high grade outside paint may be used.

Water Treatment. There are three important water problems in operating a cooling tower; (1) Protect metals against scale and corrosion; (2) the control of algae and slime; and (3) the protection of the wood. A complete chemical analysis of the water should be used as the original approach to water treatment and problems.

Scale. Some corrosion and scale-forming materials are found in practically all waters; however, the most troublesome in water cooling systems are normally calcium and magnesium carbonates and sulphates. Scale can be reduced materially or prevented by treating the make-up water. The choice of method is largely a matter of economics, and since water treatment requires close regulation and control, a competent chemist should be consulted. Regardless of the water-treatment method used, a systematic program of blow-down should be established to control the dissolved solids in the circulating water.

Algae. Algae and slime control may be accomplished by the intermittent or continuous use of chlorine, copper sulphate, potassium permanganate, phenolic compounds, or other chemicals. After continued use of the same chemical for a long time, algae may start to grow and a change of treatment would then be desirable. A pH value below 8 is necessary for effective algae control. Some forms of algae require sunshine for growth, other types will grow in shaded areas; however, the above suggested control methods will eliminate or minimize the growth of both kinds.

Delignification. Delignification is the chemical deterioration of lumber caused by the removal of lignin from the wood; it leaves the wood in long stringy fibers. Delignification is generally caused by sodium carbonate in the water; presence of sodium carbonate is generally evidenced by a high pH* value of the cooling water. It is desirable to keep the pH below 7.5.

Delignification usually occurs in parts of the tower that are alternately wet and dry. At these places, evaporation greatly increases the concentration and the ill effects of sodium carbonate. Sulphuric acid may be used to convert the carbonates to sulphates. In any case, the primary problem is the elimination of the chemicals producing delignification rather than the controlling of pH.

Tower Trouble Tips

1. Unusual noise may indicate:
   a. Loose fan hub cover.
   b. Loose bolts in fan cylinder assembly.
2. Unusual vibration may indicate:
   a. Lack of lubrication, excessive wear, or corrosion in motor bearings.
   b. Worn flexible couplings or universal joints.
   c. Excessive misalignment between electric motor and speed reducer.
   d. Inadequate or unsuitable lubrication, faulty seals, excessive moisture (including rust and corrosion), or excessive wear (backlash and endplay) in gear speed-reduction unit.
   e. Non-uniform pitch of fan blades or fan blades incorrectly assembled by blade number sequence.
   f. Loose connections in bolted joints of tower framing, particularly under speed reducer or electric motor.
3. Scale or foreign substances in the water system indicate insufficient blow-down or inadequate water treatment.

* * *

*Low pH (below 7) is acid; high pH is caustic (alkaline).

Atlantic's "Robot Brain" Probes Secrets of Oil

The Atlantic Refining Company has announced a "robot brain," which will analyze petroleum products in one-tenth the time required by existing methods. This modern analytical tool will analyze a mere trace of gas or liquid, and in a matter of minutes record the complete chemical composition on a typed sheet of paper, the company reports.

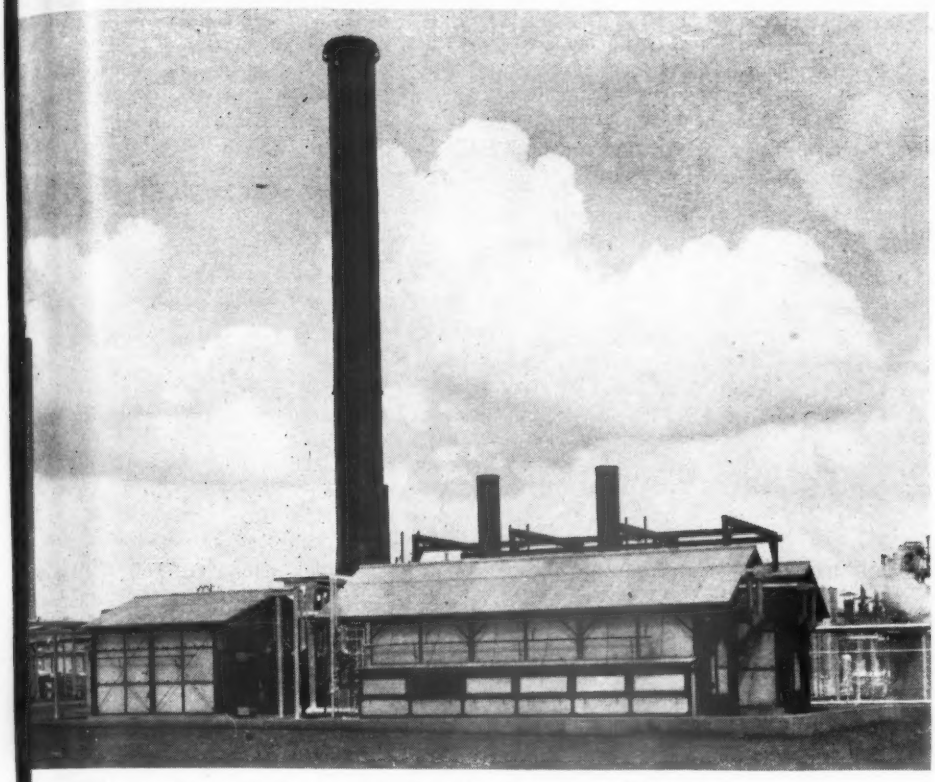
This was achieved by the linking together of an electronic counter and a mass spectrometer, one of the most important analytical instruments of the petroleum industry. The computer, dubbed the "Miniac," was developed for Atlantic by Physical Research Laboratories of Pasadena, California.

The "robot brain" was described by Dr. W. S. Young of Atlantic's Philadelphia research staff, at the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy held in the William Penn Hotel.

"The union of these two complex electronic instruments," said Dr. Young, "promises more than a ten-fold speed-up in obtaining vital information in the continual search for better quality gasolines and lubricants."

According to George Green of Physical Research Laboratories, designer of Miniac, this instrument can also be used separately on many other problems requiring high speed complex calculations. So applied, it can compute at the rate of 100,000 digits per second, or over 10,000 times as fast as the fastest human with pencil and paper.

An important link in the combination of Miniac with the mass spectrometer was a "selector" designed for Atlantic by Consolidated Engineering Corporation of Pasadena. The tool will be made available to the industry.



Heaters in Shell Oil Company cycling plant, Elk City, Oklahoma.

Relationship of Furnace Volume and Heat Release

A primary factor in practical heater design and application

D. F. GERSTENBERGER

THERE has been one processing constant that has remained unchanged since the first crude apparatus was erected for the processing of petroleum, namely the application of direct-fired heat to enable some form of distillation. Progress through the years has brought about many improvements in the methods of applying such heat in both the structural design of heaters, as well as the placing of the heat absorbing surface for proper and maximum heat absorption.

Passing from the era of the old inefficient shell still through the original pipe still, and the stage of mechanical recirculation of flue gases, we have progressed to the acceptance of radiant heat absorption as the primary factor for maximum heat transfer and efficiency.

The original pipe still, in most instances, amounted to nothing more than placing a nest of tubes in a furnace with little or no regard given to the location of the tubes in their proper relationship to radiant and convection heat absorption. In fact, common practice was to place a nest of tubes in a portion of the heater entirely removed from the combustion zone, with the design being carried out in such a manner as to cause only the products of combustion to flow through this bank of tubes. Aside from a small amount of radiancy from the gases, such heating was purely convection, and this type of design required a relatively large amount of tube surface for a given duty because of the low average transfer rates per square foot of absorbing surface. Its design is illustrated by A-1, which is a typical end elevation. The upper two rows of tubes received a relatively large amount of heat and the absorption rates diminished rapidly as the flue gases passed downward through the bank of tubes. Mechanical recirculation of flue gases had its day in improving heaters of this design by speeding up the velocity of the wash of flue gases over the tubes, thus not only increasing the Btu absorption rates per square foot of surface in the upper passes, but by further enhancing the absorption rates by the tubes furthest removed from the firing zone and a manner that an amount of 8000 Btu surface.

A-2 is an end elevation of the same type of heater as A-1 but indicates the mechanical recirculation of flue gases by the use of a low pressure large volume blower. The flue gases picked up by the blower are discharged back into the combustion section where they mix with the products of combustion, thereby creating a much higher velocity of combustion gases passing through the nest of tubes, which of course greatly increases the heat transfer rates.

The designers had to fight an up-hill battle in the early days of tube placement in the area of the heater where combustion was occurring, and to override prejudice against such design. That they did win out is apparent in the modern heater where maximum radiant heat absorption has now become standard design.

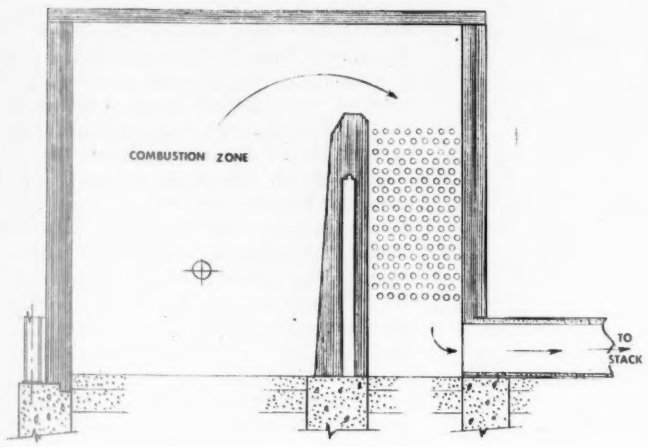
Today's improvement in tube metals, brought about principally by process changes with their attendant increased severity of heat application, have also helped in some degree the placement of heat absorbing surface in areas that in the earlier days would have been considered unthinkable. Yet there are, and

EXCLUSIVE

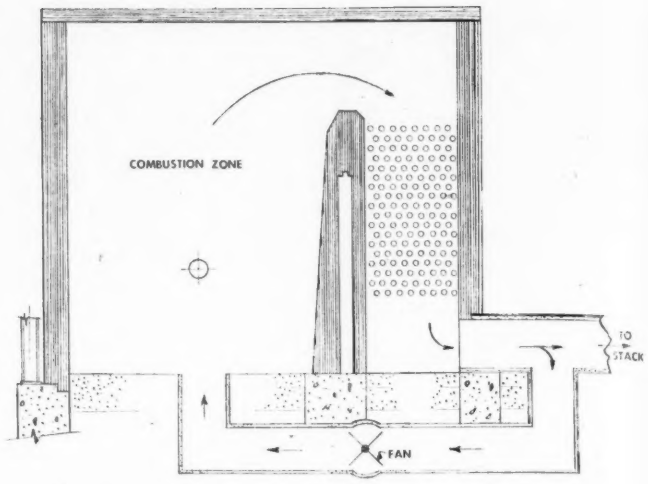
The Author

D. F. Gerstenberger is southwestern district manager of Alcorn Combustion Company. He grew up in the oil industry in the early days of liquid phase cracking developments in which he played an active part. He held executive positions with Standard Oil Jersey, Louisiana Oil Refining, American Refining, as well as being district manager for Universal Oil Products and Alcorn in the Mid-Continent and Southwest. Prior to returning to his present position in 1949, he established the Inland Empire Refineries in Spokane, Washington, purchased by Phillips Petroleum Company in 1947. He also served on numerous PAW committees during the war.

In 1948 he headed a group of engineers for the Ralph M. Parsons Company, conducting a complete economic and industrial survey of the oil industry in China Formosa.



A-1



A-2

as far as can be seen at the present, there remain, certain basic principles in good heater design that have always been prevalent controlling factors and that should continue to be considered seriously in the selection of properly designed heaters.

Primarily these principles are:

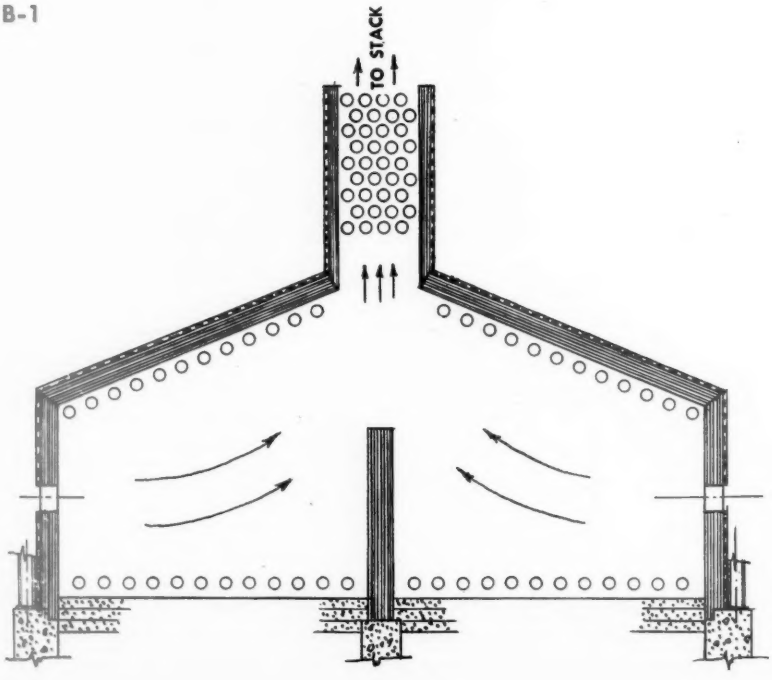
1. The proper design of the heater setting to allow a reasonable maximum heat absorption to each square foot of radiant heat absorbing surface.
2. The placement of heat absorbing surface in relation to the burners, re-radiating surface, and travel of the products of combustion in such a manner as to insure a reasonably uniform rate of heat absorption for each square foot of radiant tube surface in the heater.
3. The combination of setting design and tube placement to enable any flexibility required in absorbing varying amounts of heat in different sections of the oil flow for process reasons.
4. The placement and design of burners to insure a proper and uniform distribution of gases and radiancy and to prevent serious flame impingement and local overheating.

Depending upon the duties for which heaters are designed, we are accustomed today to think in the terms of 8000 to 15,000 Btu of heat absorbed per square foot of radiant surface. Too often, however, sufficiently serious consideration is not given to the uniformity of such radiant heat absorption, with the result that some local area in a heater becomes the limiting factor in operation or a reasonable amount of flexibility. No matter what may be considered as a satisfactory radiant rate of heat absorption for a given process duty, the design should, except in isolated cases, be such as to insure all of the radiant surface performing a similar amount of work. This can be accomplished only when the setting is designed in such a manner as to allow proper combustion and ample room for the proper flow of gases so that either by direct radiance or by re-radiance, the heat absorbing surface is all in proper relation to the heat radiating medium.

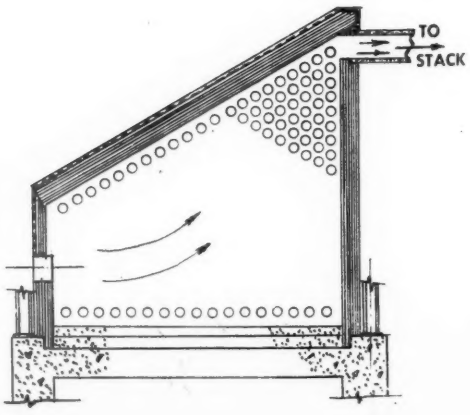
One of the better ways of setting a yard stick, for uniform radiant heat absorption, assuming all other pertinent factors have been taken into consideration in the heater design, is by giving consideration to the Btu release per cubic foot, or the amount of heat liberated in the furnace. Regardless of any statements to the contrary, this will have a direct bearing on tube life and trouble free operation.

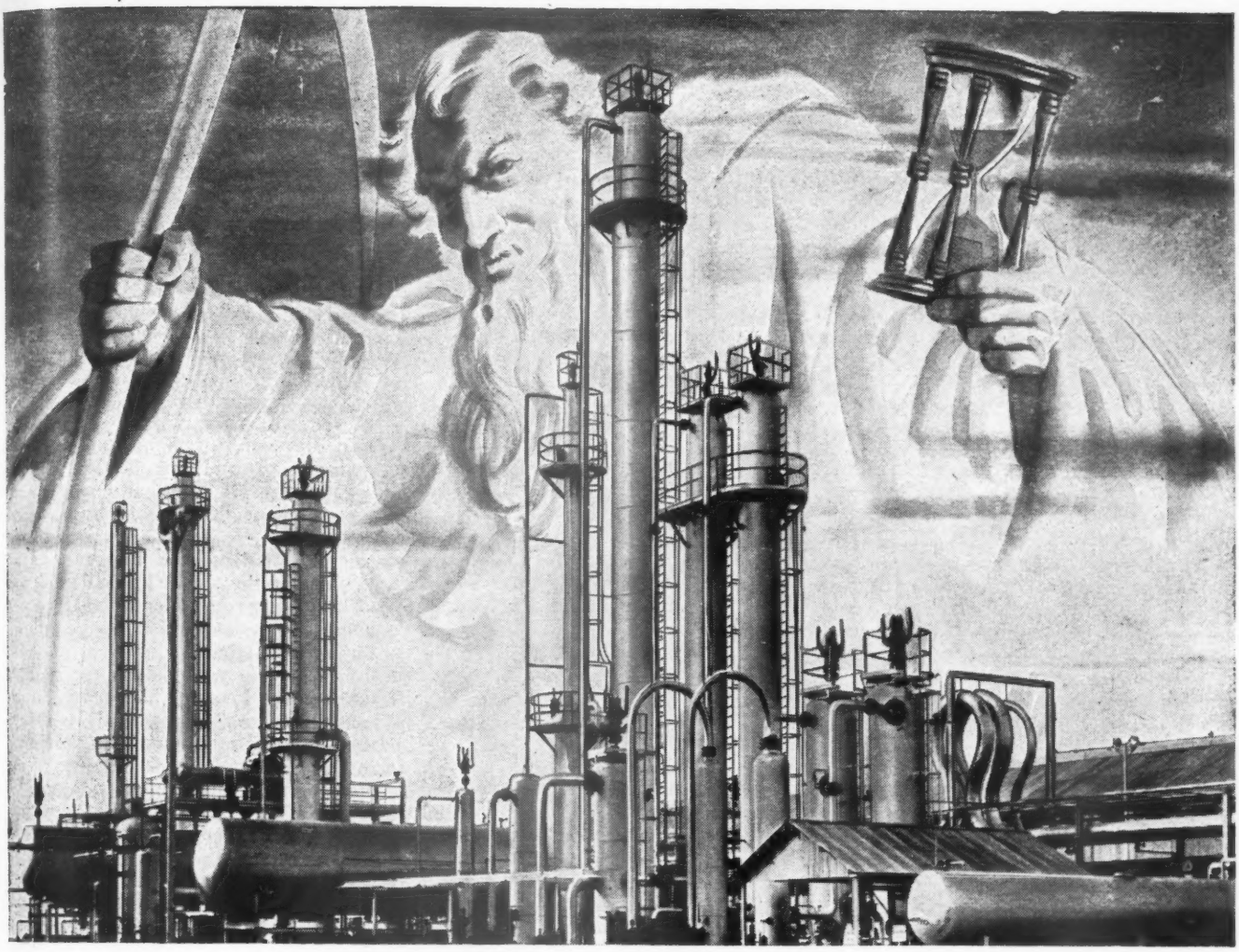
To bring this down to a common, every-day comparison, let's assume for the moment a heater designed in such a manner that an amount of 8000 Btu per cubic foot of radiant furnace volume is being released, with absorption rates of 10,000 Btu per square foot of tube surface being effected. Assume further that to absorb the 10,000 Btu per square foot of tube surface uniformly throughout the radiant surface, requires a radiant chamber in the heater of 30

B-1



B-2





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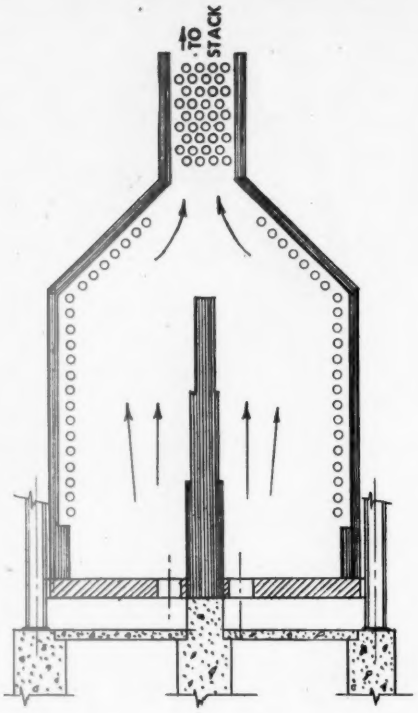
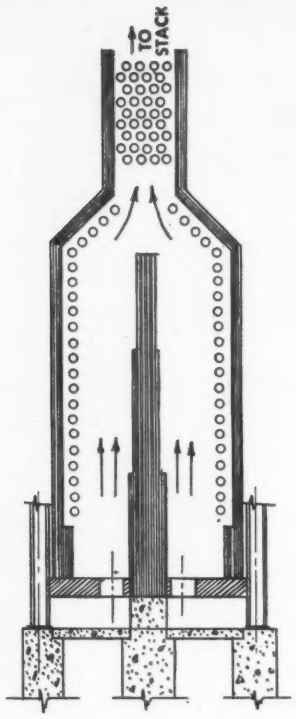


C-1



C-2

ft long by 12 ft wide by 9 ft high, dimensions that are taken from the center line of the tubes. This gives a radiant furnace volume of 3240 cu ft and accommodates a total heat release in the furnace of 25,920,000 Btu per hour at the 8000 release rate. Now what happens if we change the design in an attempt to economize on furnace structure by reducing the width, or perhaps by a combination of reduced width and some increase in height? The Btu release per cubic foot of furnace volume will increase correspondingly with the reduction in the size of the setting. Or putting it another way, the same total combustion volume will have a shorter time in which to give up its heat to the radiant surface.

If the original heater design was in balance to give a reasonably uniform distribution of heat to the radiant absorbing surface, then the smaller heater will have to operate at higher combustion zone and refractory temperatures in order to transfer the same amount of heat in the reduced time. The effect may be consequently, and invariably is, to set up higher absorption rates in those tubes closest to the point of combustion, or which look at the higher re-radiance from hot refractory surfaces. Although the 10,000 Btu rate per square foot of absorbing surface may still be maintained as an average over the entire radiant tube bank, some of the tubes will now be absorbing at higher rates, while others further removed from the higher radiant zone will receive a corresponding reduction in the amount of heat absorbed. Thus it would be possible to set up a design where theoretically a Btu release rate per cubic foot of 16,000 would result in 15,000 Btu absorbed per square foot for some of the surface graduating down to 5000 Btu absorbed in the other or cooler areas.

B-1 and B-2 are examples of heaters designed to give reasonably uniform rates of heat absorption in the radiant section. For comparative purposes heaters C-1 and C-2 are shown. All heaters are assumed to have the same duty as to the amount of heat release in the furnace. B-2 would have longer tubes than B-1 in order to establish similar average absorption rates to B-1. Comparative results for the various designs are given below. All designs except A-1 and A-2 have been calculated as having a total of 25,000,000 Btu per hour total heat release with 12,000 Btu per square foot average radiant absorption rates and 540 F average tube wall temperature. Gas has been assumed as the fuel with combustion taken as showing 25 per cent excess air.

B-1: Taking the average radiant absorption rate as 100 per cent this heater will absorb a maximum amount of heat in any one tube in the radiant section of 104 per cent while the minimum amount of heat absorbed will be in the order of 96 per cent giving a total variation in radiant absorption rates of 8 per cent. Under the conditions used for comparison, the Btu release rate in this heater would be 8200 Btu per cubic foot per hour. B-2 would have a similar spread or approximately 9 per cent variation between maximum and minimum rates. Both of these designs would safely allow for a flexibility of 20 per cent increase in total heat absorbed up to a critical limit.

C-1: By the same standards used for calculating B-1, this heater would have a maximum radiant rate of 109 per cent and a minimum of 91 per cent, or a variation of 18 per cent, the higher rate being in the tubes closest to the point of combustion. The Btu release rate for this heater under the conditions used would be 6900 Btu per cubic foot per hour. This design would permit a safe additional loading of approximately 15 per cent added heat absorbed to a critical limit, which is 5 per cent less than B-1 and B-2.

C-2: This heater, it will be noted, has a more narrow radiant zone than does C-1. The result has been to almost double the Btu release rate that now becomes 12,200 Btu per cubic foot per hour, and we find that the maximum radiant absorption rate has increased to 118 per cent with the minimum being 82 per cent, or a variation of 36 per cent over the entire radiant bank. Consequently if this design is used for an average rate of 12,000 Btu per square foot per hour absorbed, the tubes nearest the burners would be working at a rate of 14,160 Btu and those tubes near the top of the side wall will pick up 9840 Btu per square foot of surface per hour. Consequently this design allows for practically no flexibility or periodic overload without punishing the radiant tubes in the lower or high temperature zones. Reduced to practical language, this can mean but one thing. Higher rate of tube replacement because of increased oxidation or overheating or both in the high temperature absorption areas, as well as increased refractory maintenance. Unfortunately most heater designs require that the highest temperature oil stream be exposed to the highest temperature zone in the heater so that the tube metal automatically carries a heavier load and relatively higher temperatures in those critical zones in the situation just outlined.

If there is no process condition requiring a higher rate of absorption toward the end of the oil flow, and the higher absorption rates are satisfactory for this more critical area, then the heater design could satisfactorily be one in which higher uniform rates can be employed for the entire radiant bank, rather than higher rates in simply a part of the radiant section, thus effecting real economy in first cost.

Nothing has changed today to allow for any different metal temperatures up to the point of destruction for a given metal than existed say 10 years ago. In our search for economy in heater first costs consequently, we must continue to be aware of the safe limits in the distribution of absorbing surface and in heat distribution to such surface. There is still room for improvement, to enable the absorption of a uniform rate of heat around the entire circumference of the tube. When this is economically accomplished in a manner that will make possible the absorption of a given amount of heat to a lesser amount of surface, while maintaining the same relative tube wall temperatures that are prevalent in today's design, then Btu release rates for a given design will automatically increase and absorption rates will still remain uniform throughout the entire heat absorbing plane. * * *

Section of new addition to Port Arthur, Texas, refinery of Gulf Oil Corporation, insulated with hydrous calcium silicate.

P 732.4

Hydrous Calcium Silicate Heat Insulation

Extremely light weight—11 lb per cubic foot—makes handling easy; Simplified Dimensional Standards facilitates nesting and application

E. C. SHUMAN*

ALWAYS among the first to recognize and adopt improved materials and methods, the oil industry has quickly accepted a new heat insulation material of the hydrous calcium silicate type. A chemically reacted mixture of lime and silica, containing small amounts of asbestos fiber for hinging action, the new material looks quite similar to other rigid insulating materials commonly used in industry. It is not glass. In outward appearance, its distinguishing charactertistics are an almost chalky whiteness and a comparatively smooth surface texture, even when sawed.

Properly made hydrous calcium silicate is different from other insulating materials now on the market because of its unique combination of physical characteristics. Although it has a density of only 11 lb per cubic foot, it has an average flexural strength in excess of 50 psi and a compressive strength of 150 psi. Insolubility in water and incombustibility are two more of its outstanding characteristics. It is effective throughout the entire temperature range from zero to 1200 F. Because its thermal conductivity is conservatively stated at 0.39 at 100 mean or 0.54 at 500 mean temperature, it is frequent practice to specify ½-in. less thickness for Kaylo insulation than for "combination" insulating materials in the range from 500 to 1200 surface temperature.

This new material is produced under patents numbered Re. 23,228, 2,547,127, and other pending patent applications.

Hydrous calcium silicate insulation has been used principally in the medium and high temperature range, because it is in this range that the material performs to greatest advantage. It may be used also as a low temperature insulation, provided proper vapor seals are employed.

Hydrous calcium silicate insulation products of certain types have been manufactured and sold commercially by Owens-Illinois Glass Company since 1943. The story of how this company researched and developed the non-glass insulating material is interesting. It is also an inspiring example of the American Way. Without the vision, resources, and technical know-how of "big business," this material would not be on the market today.

Development of hydrous calcium silicate products began in 1938. The company wanted materials of construction to supplement its Insulux glass block, already well-established, and it had a great deal of manufacturing and engineering experience with the two principal markets used in hydrous calcium silicates—lime and sand.

Many other companies and groups have experimented with various hydrous calcium silicate products. Work had been done in Germany in the early 1930's. Several independent research organizations and manufacturing companies in the United States and Canada had attempted to develop commercial materials during this period. One group was able to produce experimentally

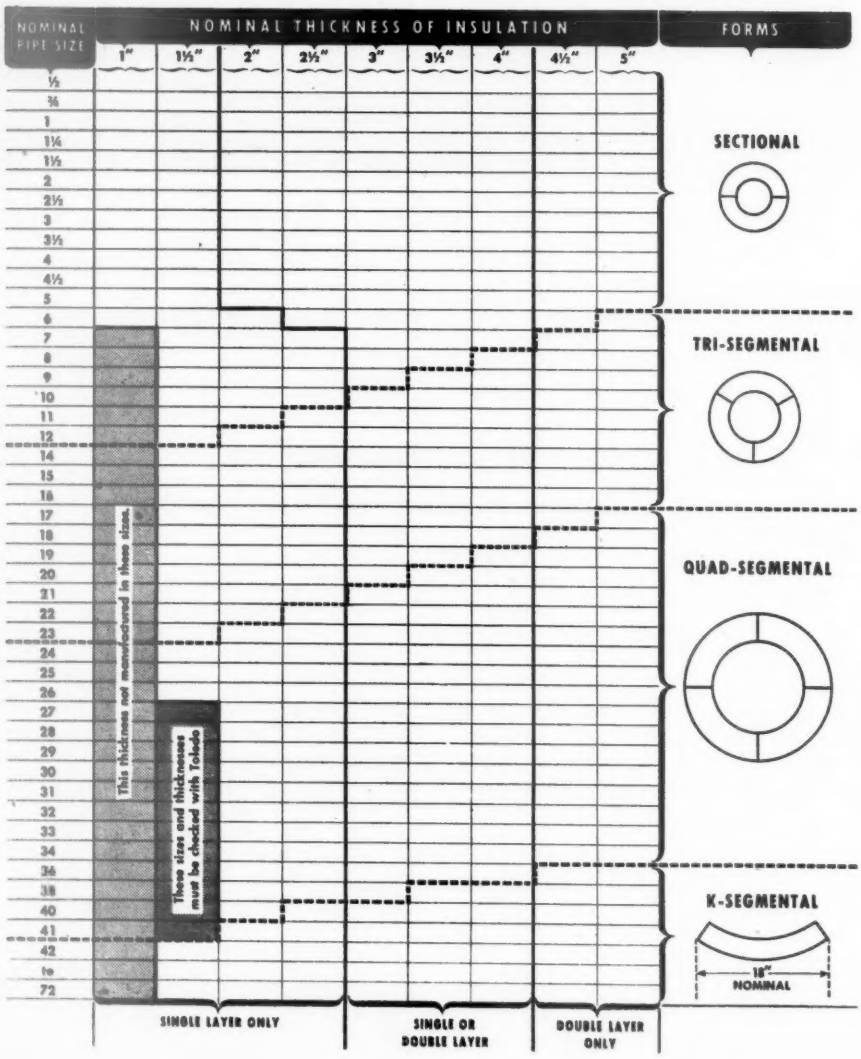
*Director of research, Kaylo Division, Owens-Illinois Glass Company.

EXCLUSIVE

Applicator saws pipe insulation to fit short run.

Standard forms of hydrous clacium silicate heat insulation.

Chart of sizes, forms, and thicknesses of hydrous calcium silicate insulation.



limited quantities of a calcium silicate product which they called Microporite. It was a structural material, and there is an experimental house on Long Island today, which is built almost entirely of this material, except those parts that are exposed to weather.

Until the company's physicists, chemists, and engineers studied the component materials and learned the details of their reactions, however, no one had produced a stable, uniform product with the advantages now found in the hydrous calcium silicate.

Research had reached the pilot plant stage of manufacturing by the outset of World War II. Hydrous calcium silicate heat insulation, then being made at a converted brick plant at Berlin, New Jersey, was approved by the U. S. Navy, which used it for marine insulation. Even in those early days, the material proved stronger, more durable, and easier to handle than others tested.

After the War, construction began on a quarter-mile-long manufacturing plant at Sayreville, New Jersey, and manufacturing of hydrous calcium silicate began there in March, 1948.

The original plant at Berlin, New Jersey, where the forerunner of today's hydrous calcium silicate heat insulation was first produced, has been remodeled and enlarged almost continually to become a sizable and modern factory, from the outside looking much like a typical glass plant. The glassman who enters it, however, finds himself in strange surroundings.

The Sayreville, New Jersey, plant, although little changed on the outside since its construction, has undergone extensive change within during the past four years as the company has perfected improved processes.

Heat loss, Btu/Lineal Foot/Hour
(Each vertical grid unit equals 12 Btu.)

Other Calcium Silicates

Calcium silicates, of course, are not new to the chemist. Portland cement may be called a calcium silicate, for example. Even some types of glass can be called calcium silicates, although being fusion products, they are not typical members of the family. Kaylo insulation, however, is a chemically reacted product, and is a permanently set and stable product when it leaves the plant. Portland cement is an incompletely reacted chemical compound insofar as ultimate use is concerned and does not reach its permanent set until mixed with water. Glass is a fused product using no water, its raw materials melted and blended at high temperatures.

The manufacturing of hydrous calcium silicate insulation is essentially a chemical reaction operation. Lime, silica. asbestos, and water are mixed to form a slurry that is poured into metal molds to shape the desired product. The reaction of this slurry is accelerated by the use of elevated temperatures in large pressure vessels called indurators. After induration, or hardening, the material is dried to practical commercial limits. It should be noted that, because a chemical reaction is involved, there is no "binder" in any Kaylo insulation.

The millions of tiny air spaces per cubic inch that are left in the material after the moisture is driven off give this insulation its light weight and low thermal conductivity. Every cubic foot of insulation contains so many tiny air spaces that the total area of the surface surrounding them is about 100 acres.

By varying the proportion of water in the formulation it is possible to obtain products in various densities. As the density increases, strength becomes greater and insulating value less. The density of 11 lb per cubic foot presently used for heat insulation was established after long research as the one that represents the optimum combination of physical characteristics for that use, from a practical viewpoint.

A 20-lb per cubic foot hydrous calcium silicate is manufactured also, in the form of two building products—insulating roof tile, for roof decking, and core material, for fabrication by other manufacturers into fireproof doors and wall panels.

Unique Combination of Physical Characteristics

The fire resistance of hydrous calcium silicate is due to its mineral composition, which withstands high temperatures. It will withstand service temperatures as high as 1200 F for an indefinite period, without loss of thermal efficiency. Actually, because exposure to high temperatures drives off residual moisture, the thermal efficiency of the material improves after installation and use.

As might be presumed from its structure, hydrous calcium silicate has a high absorption; yet it is not permanently damaged by wetting. Even when saturated, it retains a high proportion of its normal strength, and after drying it regains its normal strength and insulating value. It does not dissolve nor crumble.

Its hygroscopicity is low. After six hours exposure in an atmosphere of 120 F and 90 per cent relative humidity, for example, it absorbs only 0.9 per cent moisture by volume.

With a —pH factor of about 10, Kaylo insulation is rust-inhibitive. Contact with metal coverings or fasteners, therefore, offers no problem. This includes even

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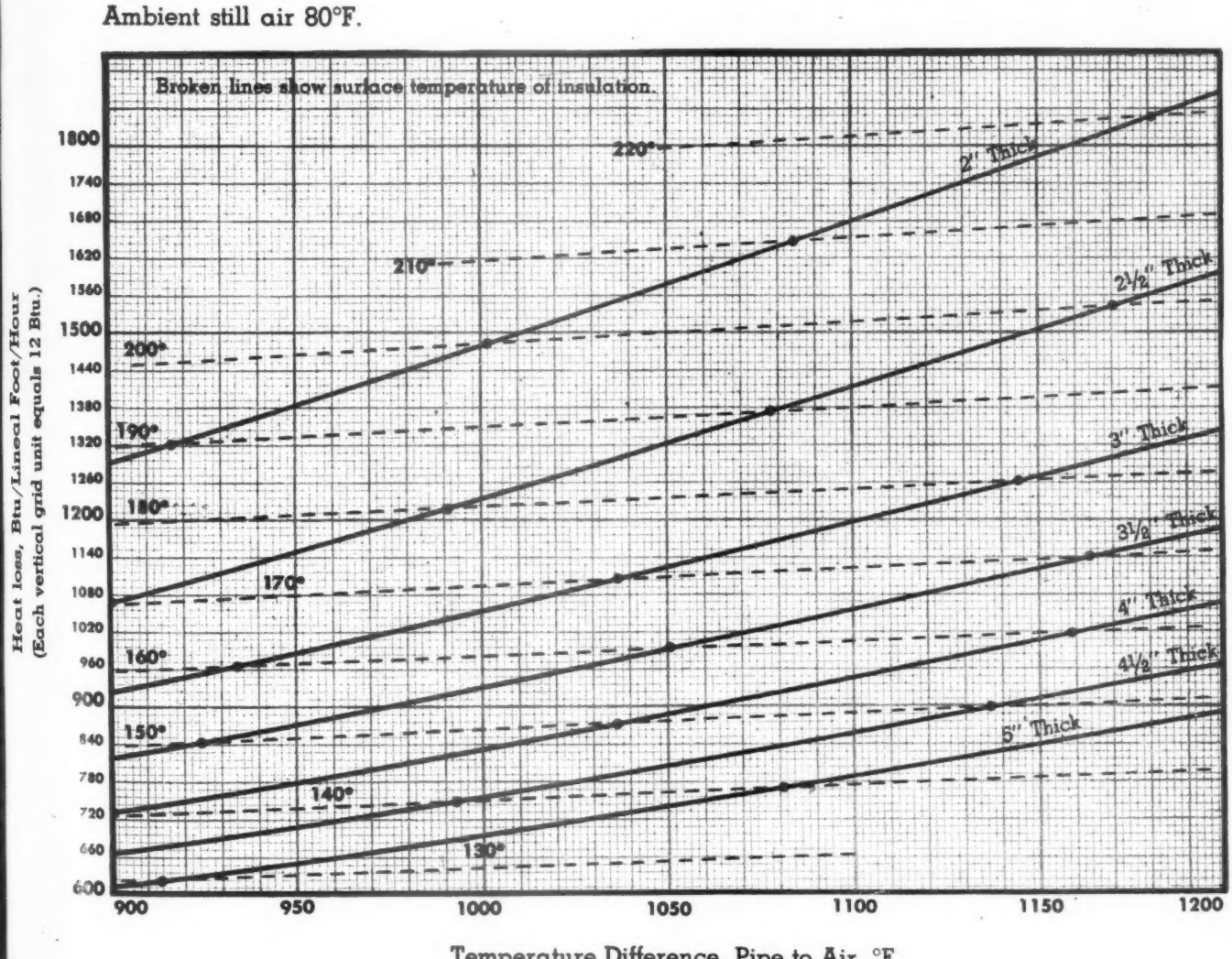
Heat loss and surface temperatures of various thicknesses of hydrous calcium silicate pipe insulation applied to 20-in. pipe.



That's entirely logical. Every refinery executive knows that a reforming job *must be done by a reforming process.* With that need in mind, Platforming was developed to provide the most efficient method of reforming low octane gasoline stocks into high octane products.

There are various jobs in a refinery that require a number of different processes. Where reforming is needed, Platforming fits the requirement perfectly. It is a true reforming process . . . specifically designed, engineered and constructed to meet the particular needs of that job.

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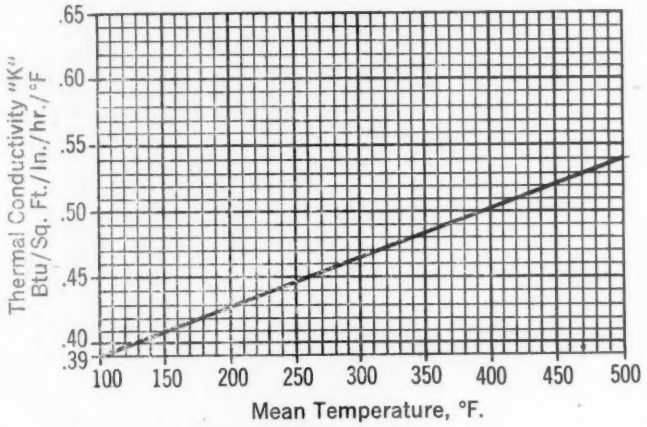

Relationship between temperature and the conductivity constant, "K."

aluminum, unless the insulation is saturated.

The material has remarkable dimensional stability. Linear shrinkage after 24 hours' exposure to a temperature of 750 F is only 0.8 per cent, and only 1.5 per cent after exposure to 1200 for the same length of time.

Wide Range of Forms

Hydrous calcium silicate heat insulation is made in two basic forms in which heat insulating block and pipe insulation are further divided into many other forms. All units are 36 in. long.

For the insulation of flat surfaces there is flat block. For the insulation of vessels from 6 to 60 ft in diameter, there is curved block. Thicknesses from one through five inches in increments of one-half inch are available for both forms. Widths are three, six, nine, twelve, and eighteen inches.

For insulation of pipes and tubes from one-half inch to six feet in diameter, Kaylo insulation is made in numerous forms, all to Simplified Dimensional Standards (successive layers "nest"). For tubes and pipes through twelve inches in diameters, it is made in sectional form (two pieces to the circumference). For diameters through 24 in., it is made in tri-segmental form (three pieces to the circumference). For diameters through 41 in., it is made in quad-segmental form (four pieces to the circumference). For diameters to 6 ft, it is made in k-segmental form (pieces nominally 18 in. wide and with various radii of curvature).

Thicknesses range from one inch through five inches, in increments of one-half inch.

The tri, quad, and k-segmental forms are unique, and are made possible only by the high strength and light weight of the material. On larger pipes, they permit the user to reduce greatly the number of pieces applied to insulate a given surface of pipe and reduce the number of joints. The applicator, therefore, handles fewer pieces, yet the light weight of the material makes these larger units easy to lift and handle.

For large pipes with temperatures above 500 F the number of pieces to be applied is reduced even further. In this range it is customary to apply double thicknesses of other insulating materials—a diatomaceous earth type next to the surface in sufficient thickness to reduce the temperature to 500 or lower, and 85 per cent magnesia or other material as an outer layer. Up to 1200, a single layer of hydrous calcium silicate (usually of lesser thickness than the former combination covering) is all that is needed.

A standard 20-in. pipe with a temperature of 700 is a good example of the labor saved by the use of hydrous calcium silicate insulation. With other standard forms and types of heat insulation, the applicator must handle 26 pieces for each 3 ft of pipe. With k-segmental insulation, he handles only three.

All sizes and thicknesses of this pipe insulation are made to Simplified Dimensional Standards. This system was devised by Ray Thomas, staff engineer for Union Carbide and Carbon Corporation, as a means of simplifying the application and storage of pre-formed heat insulation. At the time that Thomas first published his proposal for the system, this company was considering similar ideas. Hydrous calcium silicate was among the first, if not the first, heat insulation to be manufactured in conformance with his system. It is gradually being adopted by other manufacturers.

Under the Simplified Dimensional Standards system, every piece of pipe insulation is made with an outside diameter that corresponds to that of a standard pipe. Under the old system, pipe insulation is made in what are called standard and double standard thicknesses. So-called standard and double standard thicknesses are constant through certain ranges of pipe diameters. Because standard pipe sizes are often actually larger than their nominal diameters (e.g., "one-inch" pipe has an actual OD of 1.32 in., "six-inch" pipe an OD of 6.63 in.), pipe insulation made to the old system will not always nest.

To overcome this handicap, the Simplified Dimensional Standards system varies the thickness of the insulation from nominal thickness. So-called "one-inch" thick insulation for a "one-inch" pipe is actually 1.08 in. thick. "One-inch" thick insulation for a "six-inch" pipe is actually 0.94 in. thick. These variations are insignificant as to thermal conductance (and our heat loss charts take actual thickness into account). The

Owens-Illinois plant at Sayreville, New Jersey, one of two plants devoted entirely to the production of hydrous calcium silicate.

TO ALL

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GREETINGS

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April 30, May 1-2, 1952, Rice Hotel, Houston, Texas

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Western Supply Company
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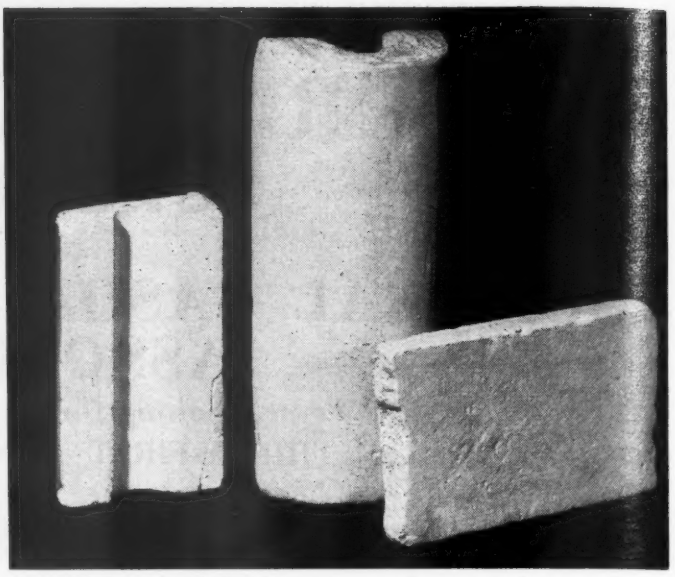
Wilkening Mfg. Co.
Woobank Machinery Company
World Petroleum
Worthington Pump & Machinery Corp.
Wyatt Metal and Boiler Works
Young Sales Corporation
John Zink Burner Company

Pieces of insulation under water a week, after being pulled out of mud left by Missouri River flood at Kansas City.



Same pieces after being cleaned under a stream of tap water and dried.

result is that insulation made to this system will always nest. Any size or thickness will fit snugly over either a standard pipe or another size or thickness of insulation.

Savings by S.D.S. System

The savings anticipated by Thomas in creating the system have proved practical. Because of the interchangeability of insulation made to this system, the number of sizes and thicknesses required to do a given job is greatly reduced. This is particularly beneficial to the user who keeps inventories of material for maintenance. He no longer need keep in stock all sizes and thicknesses that might be required for his insulated equipment. Instead, *he can stock only enough sizes and thicknesses to make up the necessary combinations.*

If processes are changed after equipment has been insulated, thereby necessitating greater insulation thickness, the user can simply apply another layer to his existing insulation. He need not remove the first insulation and apply a new, thicker covering.

It is worth noting that the 1200 F effective temperature limit of hydrous calcium silicate also applies here. Often insulations must be removed from equipment because new operating temperatures exceed 500 or 600 F limits of the material.

Savings in Application

To the engineers who design and specify and to the workmen who apply, the advantages of Kaylo heat insulation products are many, the limitations few.

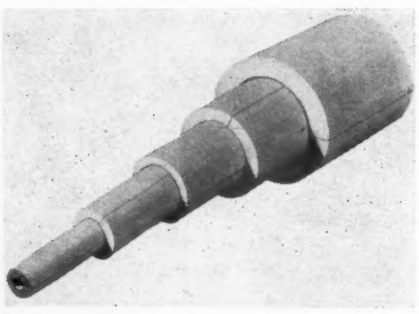
The "limitations" are tied up with the advantages. One is that the material is so strong and rigid that it cannot be broken and shaped easily around irregular surfaces, a not uncommon practice, though not considered good workmanship. On the other hand, it is this strength combined with light weight that makes it possible to manufacture and apply the insulation in larger sizes than has been previous practice. This same strength makes it possible for the applicator to cut hydrous calcium silicate insulation to fit irregular surfaces or odd spaces with an ordinary saw, or even with a knife. Applicators who use it learn the new "tricks of the trade" quickly.

Applicators appreciate the fact that hydrous calcium silicate is non-toxic and "easy on the hands."

And this high strength makes it possible to walk on insulated pipes and equipment during installation, and also reduces the amount of insulation breakage during construction. The insulation foreman on a large refinery project in Illinois where this insulation was used throughout, remarked recently that the wasted insulation for the entire job could be hauled away in a pick-up truck. Estimators are learning to use a smaller breakage factor when hydrous calcium silicate is specified.

It is not unusual for applicators to mix crushed magnesia insulation with water to form a paste and force it into small areas to be insulated. Hydrous calcium silicate, being insoluble in water, cannot be used this way. This same water insolubility, however, eliminates damage from rain before weathercoating on outside jobs, and also the need for replacing insulation if steam or water leaks occur in insulated pipes. Refining towers, insulated but not weathercoated, have withstood 3-day rains and high winds without damage.

Telescope of sectional hydrous calcium silicate pipe insulation, illustrating how Simplified Dimensional Standards allows nesting.



Hydrous calcium silicate insulation is applied in the same manner as other insulating materials. It is available either with or without canvas covering, and can be strapped, wired or pinned to surfaces being insulated. Paints of any type compatible with an alkaline surface can be used. Its nail and staple-holding power are better than average. It has good affinity for insulating and finishing cements.

Due to its compatibility with a variety of adhesives, plus the fact that it is made to Simplified Dimensional Standards, hydrous calcium silicate pipe insulation as well as block may be shiplapped to order. Shiplapped insulation fits together like shiplapped lumber, providing staggered joints in single layer application. Skilled applicators often make their own shiplapping in the field, using a saw or even a chipping hammer.

The variety of forms of heat insulation that can be made in the plant or in the field by sawing, drilling, laminating, or combinations of them is almost endless. Skillful, conscientious workmen have found numerous shortcuts using these methods. The engineer and the estimator need only to decide which product promises to be the more economical for their requirements.

Although a relative newcomer to the field this heat insulation is a proved material in the oil refinery and gas processing field. Among the companies using it for major installations are Sun, Texas, Gulf, Sinclair, Standard of New Jersey, Standard of Indiana, Standard of Ohio, Standard of California, Sunray, Pure Oil, Imperial Oil, Phillips, Shell, Cities Service, and Humble. * * *

NEW ANALYTICAL METHODS

Polarographic Determination of Zinc in Oils

J. T. Wiley*, J. E. Deloney*, and R. L. Winstead*

More and more the analytical chemist is being called upon by industry for fast, accurate analytical methods in order to meet production, striving always to provide a maximum of information in a minimum length of time. The polarograph has proved a very useful tool in helping to solve these problems.

The increased use of additives in finished petroleum products has demanded of the chemist a development of a rapid and accurate means of controlling the amount of additive present, and at the same time insuring a homogenous mixture. The determination of zinc, where it is present in the additives being used, is one of the ways this can be done.

There are a number of ways in which the zinc content can be determined accurately. There is a gravimetric procedure where the zinc is precipitated as the sulfide or as the phosphate, but these methods are too tedious and time consuming for plant control purposes where the results are needed in a few hours. There is also the electroplating method in which an electro-analyzer is used to plate out the zinc. This method gives accurate and reproducible results and is much faster than the above mentioned gravimetric procedures, and is preferred over them, however, there are times for no apparent reason the results obtained by the electroplating method are somewhat lower than those obtained by the other procedures making the method questionable.

Since it is a well known fact that zinc may be determined polarographically in any one of a number of suitable electrolytes the problem with which we were immediately confronted was a suitable method to extract the zinc from the oils. It was found that the extraction could be made with hydrochloric acid by using conventional ASTM lead extraction units; however, care had to be exercised to keep the temperature low in order to prevent bumping. Satisfactory results were obtained using this procedure, but no advantage was gained due to the time consumed in the extraction and for the wet ashing process to rid the sample of organic matter.

From previous work done on the Electroplating Method it was known that the organic matter could best be destroyed by ashing the sample and dissolving the ash in hydrochloric acid. However, we found that with hydrochloric acid alone as the electrolyte, that the zinc polarogram has a characteristic steep slope at the upper limit of the curve. Although there is a break it isn't definite enough to be desirable. By testing several electrolytes and combinations of same it was found by using a dilute hydrochloric acid-lithium chloride solution a normal polarogram was recorded.

Polarograms were made on known standard samples prepared by using zinc oxide, to determine a ratio between the current produced and the concentration. Standard samples containing from 0 to 0.10 per cent by weight of zinc were analyzed. Current produced versus concentration of zinc is a straight line function.

*The Texas Company.

Apparatus

Model XXI Sargent Polarograph (or any other suitable instrument).
100 ml. vitreosil dish.
100 ml. volumetric flask.
20 ml. pipette.
10 ml. pipette.
Water jacketed electrolysis vessel — Sargent S-29307 (or any other suitable cell).

Reagents

0.05 per cent gelatin in aqueous solution.
C. P. zinc oxide.
0.25 N hydrochloric acid solution, aqueous.
0.5 N lithium chloride solution, aqueous.
20 per cent hydrochloride acid solution, aqueous.
Nitrogen — 99.9 per cent purity (unless chemically pure, it should be purified).

New Feature Service for Refining and Gas Processing Readers

With this issue, *Refining and Gas Processing* institutes a new department devoted to the general field of analysis, inspection, and testing of petroleum and natural gas and their various products and fractions. Here will be, for the first time in any oil industry publication, a forum in which these new developments can be presented for the information and use of all members of the industry who are interested in this most important division of its operations. It is well granted that the publication and general dissemination of new methods and procedures, to bring them to the attention of others interested in these fields, leads eventually to improved methods, which serve more efficiently the needs of the industries concerned.

Finding a need for such a medium of information exchange we are publishing a regular succession of new developments in the analytical phase of our growing technology. Data and procedures published generally will be non-standard methods developed by qualified technical men and organizations; discussions of analytical data or scientific principles as they involve and control analytical methods, and specific test routines for the determination of quality and specifications of products. Standardized methods will not be included except on very rare occasions; revisions of standard routines are of special interest in this regard and are invited.

Contributions in all phases of this wide field are invited from the entire industry, not only the specialized and carefully fixed routines but also discussion of details and principles affecting the results obtained, requirements, and limits of utility of methods and other pertinent data of wide interest to all in the technical division of petroleum and natural gas. The total of many investigations by a great number of contributors is required normally to develop a satisfactory test procedure. It is the intention of the publishers to make this new feature as comprehensive, varied, and widely useful as it is possible to make it. The subjects to be covered include every phase of refining and gasoline plant operations, research and development, analytical process control, process and equipment evaluation and investigation, systematization of maintenance, repair and inspection methods, and similar activities.

Readers are urged to send in contributions along these lines, with the certainty that the more cooperation employed the greater advantage will accrue for everyone who studies these articles.

—EDITOR,
Refining and Gas Processing.

Procedure

Weigh the sample (0.5 to 50 grams) to be analyzed into a 100 ml. vitreosil dish and ignite carefully until all organic matter is removed. Add 10 ml. of 0.25 N hydrochloric acid and heat for approximately 5 minutes. Quantitatively transfer to a 100 ml. volumetric flask, add 20 ml. of 0.5 N lithium chloride* and one ml. of 0.05 per cent gelatin and make up to volume with distilled water. After mixing the sample, transfer a portion to the electrolysis vessel, and bubble nitrogen through the solution for approximately 5 minutes to remove any oxygen that may be present. Electrolyze the sample between −0.65 and −1.2 volts while maintaining a constant temperature and mercury flow. Determine the sensitivity setting and the damping position by the concentration of the zinc.

Because of the varying amount of zinc present in different oils, the sensitivity may have to be changed frequently. Therefore the calculations are based upon the current produced.

Step height of standard × sensitivity = Micro-amperes current produced for a known amount of zinc.

Step height of unknown × sensitivity = Micro-amperes current produced for an unknown amount of zinc.

*If difficulty is encountered getting the ash in solution with the dilute hydrochloric acid and lithium chloride, add approximately 20 ml of the stronger 20 per cent acid, and filter. Then evaporate the stronger acid to the residue, after which it can be taken up in the dilute hydrochloric acid and lithium chloride solutions that would eliminate the steep slope that is usually obtained when using strong acid.

TABLE 1. Analysis of per cent zinc in oils.

Identification	Polarographic method	Electroplating method	Gravimetric method zinc Ppt. with H_2S	%Zinc (Zn.) added
Sample A*	0.0	0.0	0.0	0.0
Sample B	0.010—0.011	0.007—0.008	0.009—0.012	0.010
Sample C*	0.030—0.030	0.028—0.026	0.029—0.028	0.030
Sample D*	0.050—0.051	0.050—0.049	0.051—0.050	0.050
Sample E	0.076—0.074	0.075—0.070	0.077—0.078	0.075
Sample F	0.110—0.110	0.092—0.096	0.110—0.130	0.100

* An additive containing barium, phosphorus, and calcium added to oil.

Weight of zinc in sample = Micro-amperes current produced in unknown × known amount of zinc in Standard.

Micro-amperes current of known per cent zinc

$$= \frac{\text{weight of zinc in sample} \times 100}{\text{weight of sample}}$$

Results

The results shown in Table 1, were obtained on oil samples to which known amounts of zinc were added, using the subject polarograph method, an electroplating method using an electro-analyzer, and the gravimetric procedure in which the zinc was precipitated with hydrogen sulfide.

The data obtained in Table 1 indicate that the three methods check fairly closely and each gives reproducible results. Slightly lower results are obtained at times with the electroplating method, which is probably due either to the failure to plate out all of the zinc or to some of it being lost in handling after being plated out on the platinum electrode.

The gravimetric procedure gives good results but is too tedious and time consuming, and where other elements are present in the sample, as was the case in Sample A. C, and D, special handling is required to avoid interference, whereas, none of the three elements interfere with the polarographic procedure. The polarographic method gives its most important advantage in being much faster than the other two and is just as accurate.

The subject method has proved satisfactory for the determination of zinc in oils. It is much faster, is as accurate, and the results are easier to reproduce than either the gravimetric or electroplating methods. Also elements such as phosphorus, barium or calcium, often found in additives used in motor oils, do not interfere with the determination. The method has been used satisfactorily on oils containing from 0 up to as high as 10.0 per cent zinc. It has also proved equally adaptable to used oils.

Acknowledgment

The authors are grateful to Harold G. Sprague of The Texas Company Beacon Laboratory, for his assistance in working out this method. * * *

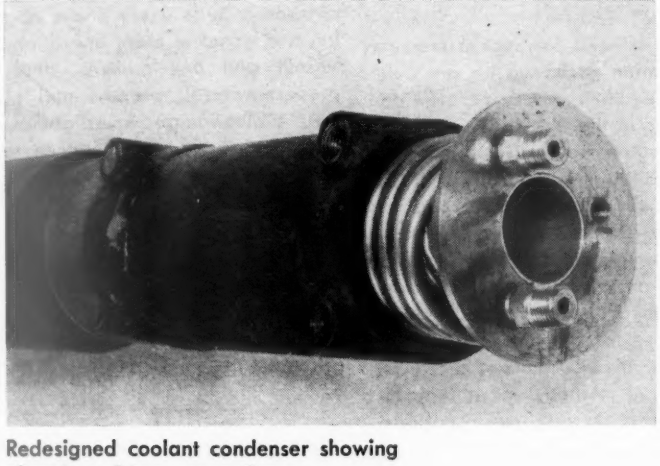
HOW TO SERVICE COOLANT CONDENSERS

N. F. Nichols*

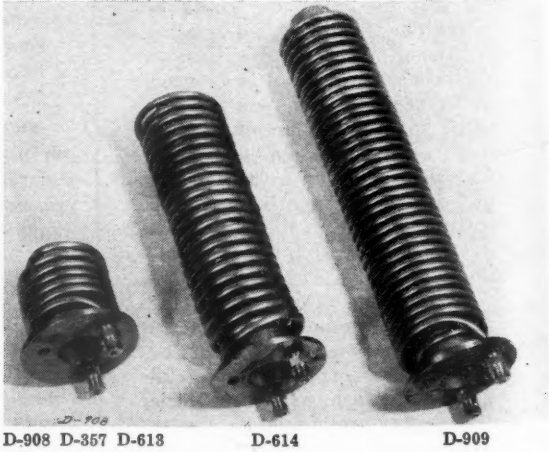
To improve accessibility and reduce maintenance time when servicing coolant condenser bodies and coils, the following change in design has been made and used successfully.

The original design of the coolant condenser has two ¼-in. pipe connections at the top edge of the cast iron body, through which the ends of the copper tubing coil are pulled (a

*Supervisor engine laboratory, Richfield Oil Corporation.

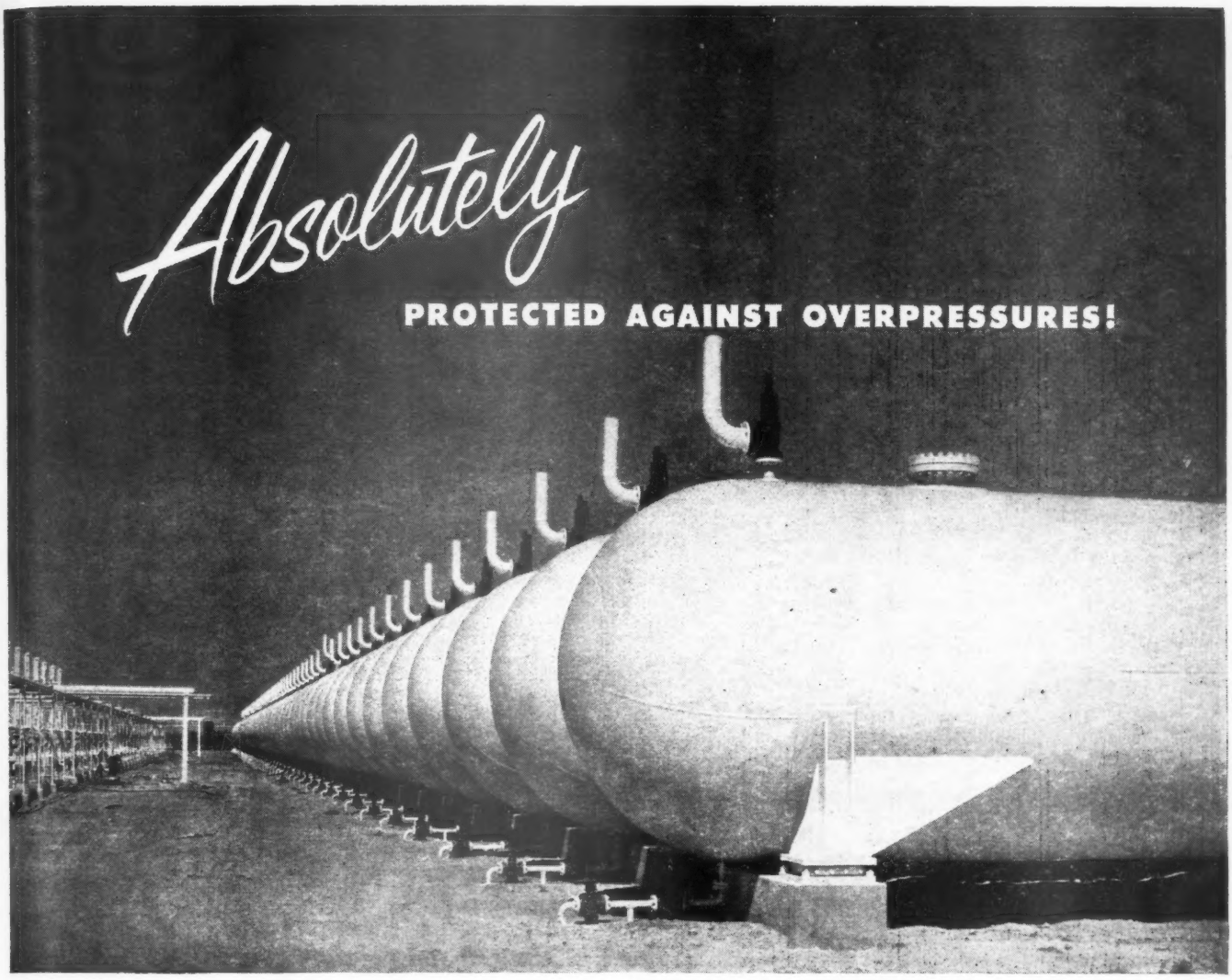


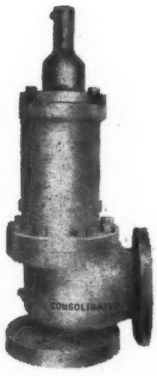
Redesigned coolant condenser showing plugging of two connections.



D-908 D-357 D-613 D-614 D-909

Different lengths of coil for use with CFR test engines.





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difficult operation). One-fourth-inch brass pipe nipples are placed over tubing ends and made up tight in the body connections; the tubing is then soldered to the inside of the pipe nipples and the tubing ends trimmed off flush with the nipples.

To enclose the top of the body, a cast iron cover with a tubular extension reaching down inside the copper coil is provided to improve vapor to coil contact. This cover may be reworked or a new one may be made as shown in the attached sketch. The extension (A) is cut off and the cover bored out for a light press fit on the stainless steel tube replacement (B) (no welding or brazing necessary). A drop-in type plug (C) may be used for the filler opening instead of the screw-in type (D) on the original cover.

Three different condenser body lengths are needed to accommodate the five test methods: The short body for ASTM Method D-908, D-357 and D-613, the long body for D-614 and the long body plus a short upper extension for D-909. This extension piece carries a separate coil that requires external connections to the lower coil. The modification of the condenser bodies to accommodate the single unit coils of three different lengths (shown in the photograph) are as follows:

For the short body no change; for the long body, bore out the ridge (E) so that the single unit coil will pass into the lower body; for the long body plus the extension, machine out the bottom ridge (F) of the extension piece, chamfer the outside corner and braze the extension piece to the long body, thus eliminating all joints and the external pipe connections of the original equipment.

These modifications have been in use in Richfield Oil Corporation's engine laboratory for a year and have proved to be a decided time saver when purging of the condenser coils becomes necessary due to scale or dirty water deposits. This method also has made it unnecessary to remove the condenser body from the cylinder assembly to service or replace the coils. * * *

HEATER FOR ANILINE POINT APPARATUS

H. D. Terrell*

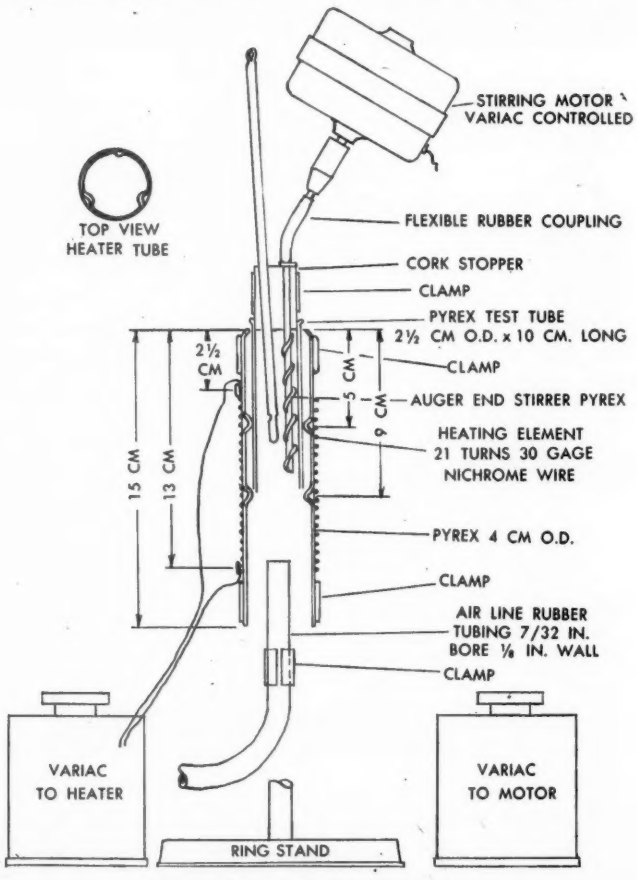
THE accompanying drawing illustrates a simple and efficient heater for ASTM D 611-46 T, "Tentative Method of Test for Aniline Point and Mixed Aniline Point of Petroleum Products" and for ASTM D 1012-49 T, "Tentative Method of Test for Aniline Point and Mixed Aniline Point of Hydrocarbon Solvents".

A piece of Pyrex glass tubing, approximately 15 centimeters long and four centimeters in diameter, has three equally spaced notches pressed into the top of the tube deeply enough to hold the flared top of a two and one-half centimeter by ten centimeter test tube, but with enough space to allow the test tube to be inserted into the Pyrex glass tube. Approximately five centimeters from the top of the Pyrex glass tube, three indentations are equidistantly pressed into the side of the tube, deeply enough to center the test tube but with enough space to allow the test tube to be inserted past the indentations. Approximately nine centimeters from the top of the Pyrex glass tube, another series of three notches is pressed into the side of the tube in the same manner. Approximately two and one-half centimeters from the top of the Pyrex glass tube, a small glass knob is attached, and approximately 13 centimeters from the top of the tube a similar glass knob is attached. These glass knobs are used as anchor terminals for approximately 21 turns of 30 B and S gage nichrome wire, which is wound around the outside of the tube. Two strips of thin asbestos cord are placed vertically on the outside of the tube and on opposite sides to hold the nichrome wire in position. The ends of the nichrome wire are connected to a variable transformer.

By adjustment of the variable transformer a mixture of sample and aniline in the test tube can be heated as slowly or as rapidly as desired, or can be held at any desired temperature. An air jet is placed in the bottom of the tube, so that the mixture in the test tube may be rapidly cooled, if desired.

With this apparatus, the mixture in the test tube can be heated from room temperature to 200 F in four or five minutes and can be cooled in about the same time. As there is no inertia problem in regard to heat, and as there is no heat interference with change from one sample to another due to the heat flexibility of the apparatus, samples may be run in rapid succession with this simple and efficient apparatus. The heater is transparent, which makes it quite easy to observe the precise aniline point.

The heating device, described above, may be used with minor changes for heating the aniline point U-tube apparatus or the aniline point thin-film apparatus, currently shown in ASTM D 611-47 T. * * *



Heater for aniline point apparatus.

*Section head, refinery technology laboratory, technical division, manufacturing department, Gulf Oil Corporation.

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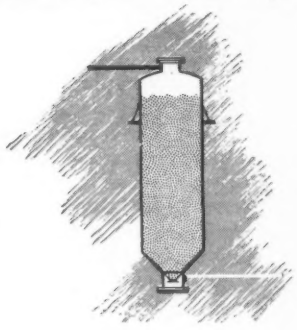

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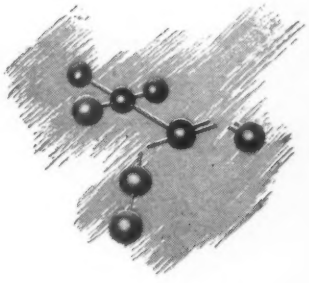

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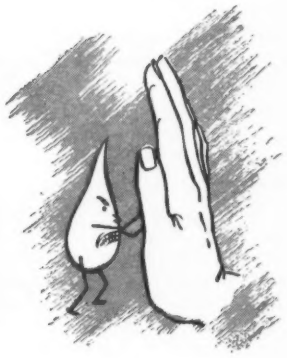

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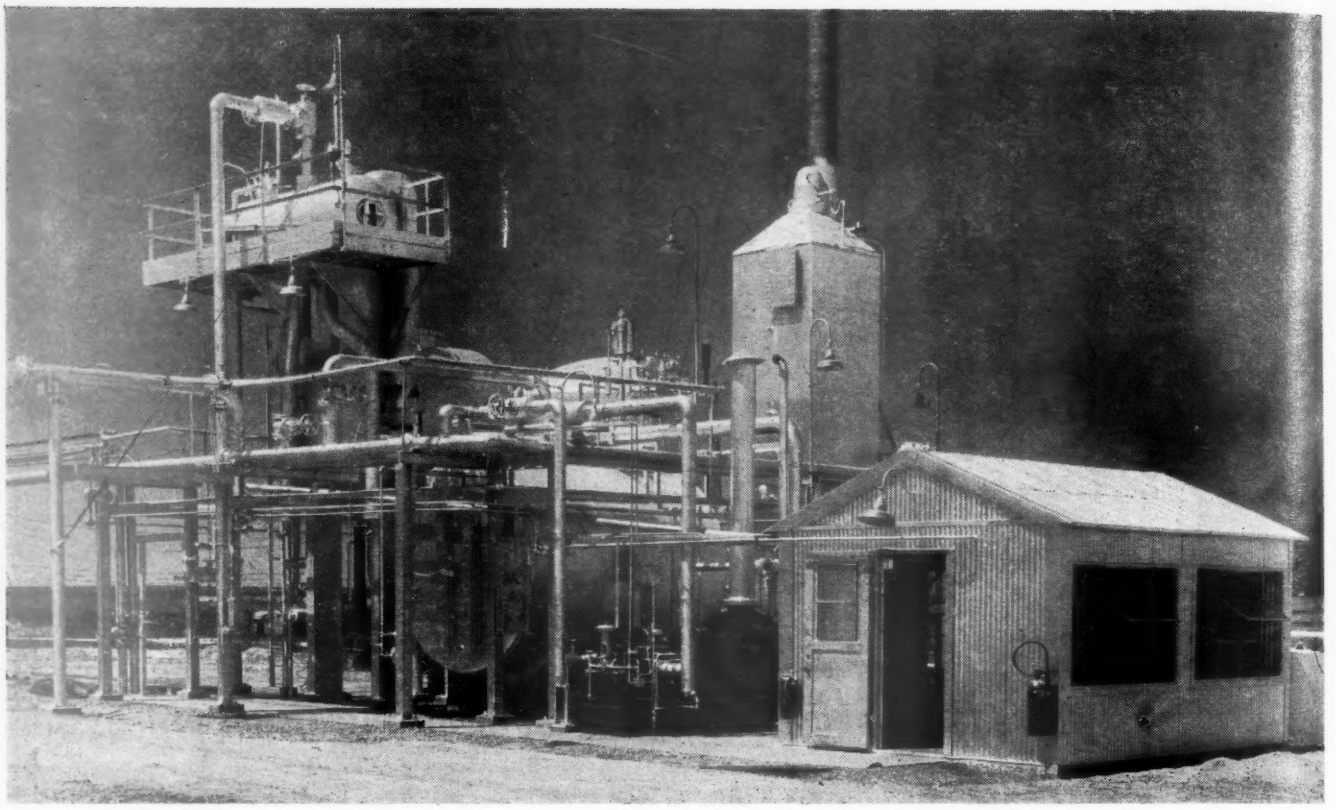


Sulfur conversion plant of Shamrock Oil and Gas Corporation has design capacity of 30 tons a day.

Processing Sulfur Bearing Gases†

Recovery of sulfur from sour gases has achieved a position of considerable importance in the present day economic situation

C. L. BLOHM*

DURING the past decade, sour natural, and refinery gases have acquired a position of considerable economic importance. In contrast to past practices of disposing of such gases by flaring or of ignoring them by not bringing them to production, the present practice is to produce such gases as a conservation and economic measure for both their hydrocarbon and sulfur contents. Thus, the processing of hydrocarbon gases containing the acidic constituents, hydrogen sulfide and carbon dioxide, has progressed from an original basis of simple nuisance or hazard elimination through gas treating in large quantities for the production of salable domestic and industrial fuel to the present status of gas sales plus production of elemental sulfur or sulfuric acid, and in at least one instance, production of carbon dioxide in the form of dry ice. A brief review of this progress with principal emphasis on the sulfur production phase is the subject of this presentation.

Gas Treating Processes

The general subject of the treatment of hydrocarbon gases for removal of both hydrogen sulfide and carbon dioxide has been discussed in the literature to a considerable extent in the past few years and needs no further detailed exposition. It might be well to review briefly the development of such processes to their present status. The earliest developments in the processing of gases for hydrogen sulfide removal were engendered by the need for such treatment of manufactured gases to remove objectionable odor and possible hazard, or for requirements of specific processing in which the presence of hydrogen sulfide may have been otherwise undesirable. Probably the earliest such process employed lime slurries, which were subsequently replaced by iron oxide beds or slurries to be followed by the development of inorganic chemical reaction processes such as the Koppers Seaboard Process using soda ash, the Thylox Process employing sodium thioarsenate, the Shell tripotassium phosphate process, and the sodium phenolate process. Foreign processes such as the "Alkazid" process, which employed amino acids, and the Staatsmijnen-Otto process, which employed the oxidation

†Prepared for the Natural Gasoline Association of America Regional Meeting, Odessa, Texas, February 29, 1952.

*Assistant manager, research and development, The Fluor Corporation, Ltd., Los Angeles, California.

reduction system provided by a solution of Prussian Blue (ferri-ferrocyanide) were also developed. All of the above processes, although reasonably satisfactory for specific applications, had individual disadvantages and were not particularly amenable to the use of high pressure purification of large quantities of natural gas to the purity required by most states, viz., less than 0.25 grain hydrogen sulfide per 100 SCF. A comprehensive review of such processes has been given by Blohm and Chapin[1].

The impetus for the application of organic amine regenerative processes to the removal of both hydrogen sulfide and carbon dioxide from gases was provided by the investigations of R. R. Bottoms[2], who obtained his earliest patent in 1930 for the use of such materials in this manner. Although Bottoms' patent covered the use of a great number of organic amines free of carbonyl or carboxyl groups (to distinguish them from the amino acids), the amines of commercial importance in this application have been pretty generally confined to a specific group of alkanolamines, particularly the mono di- and triethanolamines. Of these, monoethanolamine has received greatest acceptance for the high pressure treatment of natural gases, although diethanolamine has found considerable application in lower pressure treatment of refinery gases, particularly where liquid treating of LPG or gasoline has been concurrently desirable.

There have been some improvements in the application of these amine processes, the most significant of which is covered by a patent issued in 1939 to A. J. L. Hutchinson[3] describing the glycol-amine process, the principal feature of which is simultaneous desulfurization, carbon dioxide removal, and dehydration in a single stream process. The fundamental flow scheme of Bottoms' original process has not been altered, except for minor modifications such as, for example, the two-stream processes disclosed by Shoeld[4], McCartney[5,6], and Chapin[7], or the use of regeneration at elevated pressures disclosed by Reed[8].

Over the period of the last decade, the continued large scale application of the above processes has demonstrated their economic and technical suitability, the principal difficulty with their use being corrosion of carbon steel equipment, particularly heat exchanger and reboiler surfaces. A considerable amount of effort has been expended in the study of these corrosion phenomena by several investigators[9,10,11,12] and to date several reasonably satisfactory solutions have been provided, although the problems are still of some significance in certain specific installations.

An important outgrowth of the treatment of both natural and refinery gases for hydrogen sulfide removal has been the increasing necessity for satisfactory means of disposal of this undesirable and toxic material. In the past, general practice in natural gas treating has been to dispose of the hydrogen sulfide by adding sufficient hydrocarbon to the acid gas stream to make it satisfactorily combustible and flaring the combustion products to the atmosphere. In most instances this has been expedient, but not altogether satisfactory disposal means. In the application of gas treating processes, however, in most refineries that are usually located in populous areas it has been necessary to resort to other methods due to the unpleasant and noxious character of the combustion products from simple burning, plus the impositions placed on such procedure by atmospheric pollution controls. The most generally adopted practices until very recently were either that of diluting the acid gas with large quantities of hydrocarbon that were then used as plant fuel, or the sale of the concentrated hydrogen sulfide to adjacent sulfuric acid plants where it was possible to make such arrangements. In any event, the disposal problem had always provided a processing difficulty and was usually an operating expense.

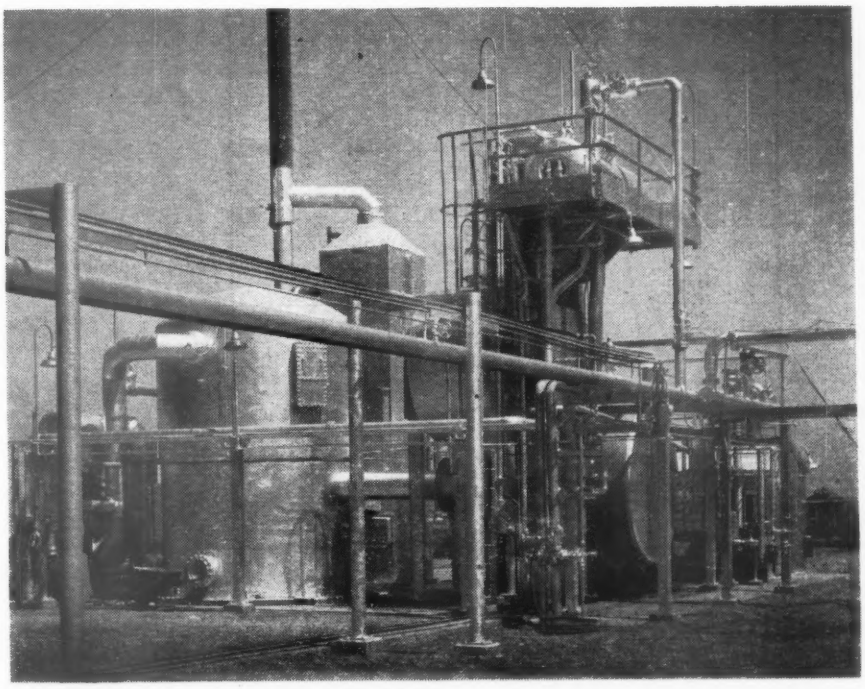
A rather obvious solution to the above problem had been available to the industry for several years, but had been considered uneconomical and prior to 1946 had been applied only in one specific instance where the economics were quite favorable. This, of course, is the production of elemental sulfur from the waste hydrogen sulfide streams, a discussion of which follows.

Sulfur Recovery Processes

Although the basic principles of the conversion of hydrogen sulfide to elemental sulfur have been known for many years and were employed in Europe and other foreign locations in the Claus-Chance process[13,14], the principal credit for the commercial development of the process in this country goes to the Southern Acid and Sulfur Company (now a part of the Mathieson Chemical Corporation) who, during 1944 built and started operation of a plant to process the vent gas resulting from the operations of the McKamie Gas Cleaning Company. Operations at the McKamie plant proved so successful that the same company constructed a second plant in 1946 at Magnolia, Arkansas, utilizing the acid gas flared at the Arkansas Fuel Oil Company's Columbia plant[15]. Again in 1951 Mathieson Chemical Corporation expanded the original McKamie plant to approximately twice its original production capacity.

The impetus for the construction and operation of these earlier plants was provided by the fact that the operating company in this particular instance was already in the business of buying sulfur and producing sulfuric acid and found that due to the favorable location and other factors involved, the sulfur conversion process was economically attractive. There was little or no interest in such processing by companies engaged in gas treating at that date, however, as mined sulfur was readily available, inexpensive, and at a source where cheap freight rates were applicable. This situation, however, began to show change in 1948 to 1949 due to the increase of world sulfur demand and resulting production shortage. Coupled with this were price changes in mined sulfur that gave sulfur from hydrogen sulfide a slightly more favorable position and the increasing necessity in populous areas for reduction of atmospheric pollution due to combustion of sulfur bearing gases. Based on the latter requirement to a considerable extent, the third plant to be constructed and operated in this country was that of the

Another view of the Shamrock sulfur conversion plant.



Hancock Chemical Company in the Los Angeles area, completed in 1948, which purchased hydrogen sulfide from several nearby refineries and in a composite operation converted this to elemental sulfur that was sold to local sulfuric acid manufacturers. Since that date this same plant has been expanded to twice its original capacity and a considerable number of similar sulfur recovery plants have been or are presently being constructed throughout the United States, Canada, and Mexico.

The basic chemistry and technology of the currently used conversion process have been described adequately elsewhere[15] and therefore need only brief review here. The conversion depends upon the simple over-all reaction:

$$3\ H_2S + 3/2\ O_2 \rightleftarrows 3\ S + 3\ H_2O$$

Actual plant designs can be modified to a considerable degree to satisfy the requirements of any specific application, but for purposes of illustration a flow diagram using two catalytic conversion stages will be described.

Looking for a moment at the basic chemistry of the reaction noted above, it should be observed that the simple equilibrium indicated is composed in practice of several equilibria involving sulfur dioxide, which is formed as an intermediate, and the several different molecular forms of sulfur existing in the vapor. The relative quantities of the various sulfur species are found to depend on temperature and sulfur partial pressure[16].

In Fig. 1 there is shown the theoretical equilibrium conversion curve for pure hydrogen sulfide burned with the stoichiometric quantity of atmospheric air at one atmosphere total pressure according to the reaction shown. In the reaction equation, the subscript "n" has been used to indicate sulfur in its several molecular forms. Obviously, this equilibrium conversion curve will be altered for other conditions in which the hydrogen sulfide is diluted with hydrocarbon or inert gases or in which the total pressure on the system may be different than that indicated. In the same figure there is also shown a curve representing the sulfur dew point of the product gas, again for the specific conditions indicated, which curve is of importance in commercial operation as it is necessary to maintain the catalytic conversion beds at a temperature above the dew point curve in order to prevent condensation of sulfur on the catalyst surfaces. It is apparent therefore that for operation under these specific conditions the maximum theoretical conversion attainable in commercial practice will be in order of 93 per cent as indicated by the intersection of the two curves.

If the equilibrium conversion curve is displaced downward because of dilution of the feed hydrogen sulfide to less than 100 per cent concentration, the partial pressure of the product "S_n" will also be lower so that the sulfur dew point of the resultant product gas will be displaced to the left of the curve indicated. Again, if part of the sulfur content of the product gas is condensed and removed as, for example, between stages in a two-stage conversion process, the dew point of the product gas in the second converter will be decreased accordingly and it will be possible to operate at a lower and therefore more advantageous temperature. The removal of one of the reaction products (sulfur) also has the effect of shifting the equilibrium in the direction of increased yields. It is apparent, therefore, that commercial recoveries in excess of the 93 per cent indicated in Fig. 1 may be achieved, but only by careful manipulation of temperatures, pressures, and other process design variables.

A typical plant layout and process flow diagram are shown in Fig. 2. The process flow pattern is readily discernible from the figure and can be considered typical of a two catalytic conversion bed unit with interstage cooler and/or condenser. Many modifications of this process have been employed by various designers to fit specific conditions, and descriptions thereof are available in the literature. The typical plant layout in the same figure is of some interest since it indicates the very compact manner in which a sulfur conversion plant of reasonable capacity can be constructed. A plant of the type indi-

FIG. 1. Theoretical equilibrium conversion and dew point curves for burning pure H_2S in reaction as shown.

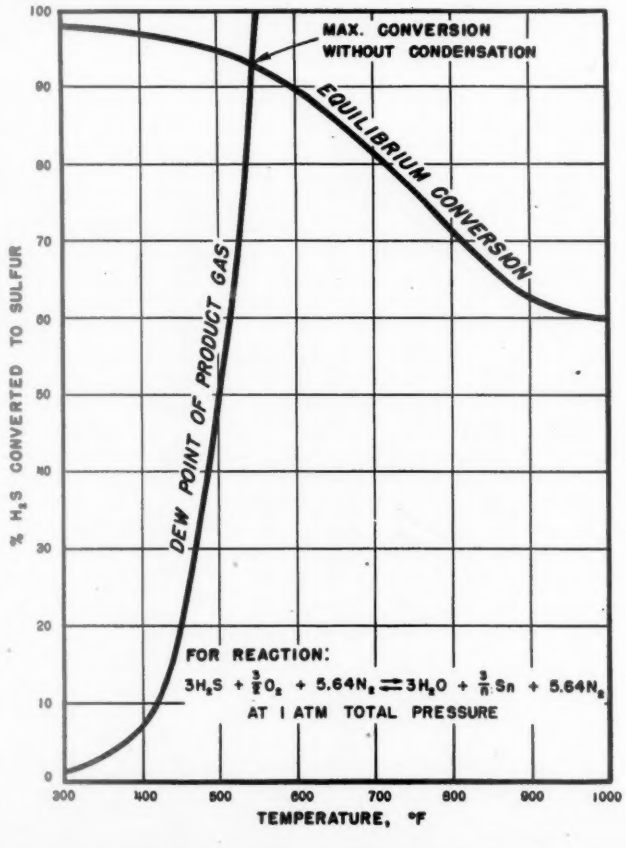
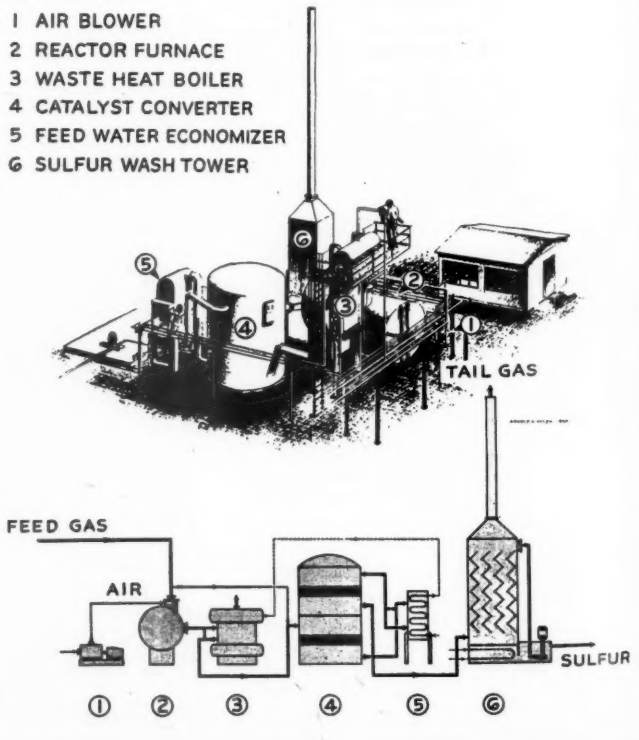


FIG. 2. Schematic typical plant layout and process flow diagram for two catalytic bed unit.



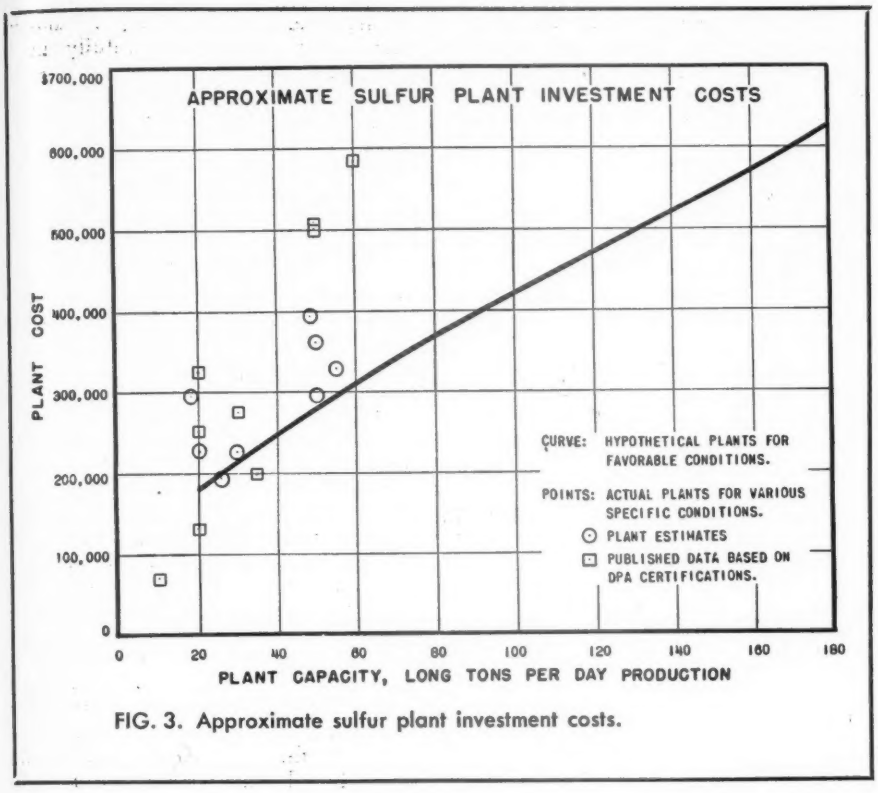


FIG. 3. Approximate sulfur plant investment costs.

cated for the production of 30 long tons per day of elemental sulfur, exclusive of control house and loading or storage facilities, can be erected within the limits of a site measuring 40 by 50 ft, that is, 2000 sq ft. With regard to the requirements for storage facilities, it is of interest to note that while many of the earlier plants of this type stored bulk solid sulfur in a manner similar to that used by the sulfur mine operators, recent practice wherever feasible has been to load liquid sulfur directly into tank cars fitted with steam coils and to transport and unload the sulfur in liquid form, saving considerable time, labor, and space in handling costs.

Economics

Let us now consider the investment and operating costs involved in the production of elemental sulfur from waste hydrogen sulfide[17]. For purposes of economic comparison, plants will be considered which utilize essentially the flow diagram indicated in Fig. 2 and operate with a feed gas containing approximately 75 per cent hydrogen sulfide, less than 2 per cent hydrocarbons (principally methane) and the remainder carbon dioxide. This gas stream will be available to the sulfur plant at a temperature of 100 F, saturated with water and at a pressure sufficient to drive it through the sulfur plant, which in general will not exceed 5 psig. As other operating facilities such as the gas treating plant will usually be in the immediate vicinity, it is assumed that utilities such as cooling water, boiler feed water, electricity, and start-up fuel and steam are available at the plant site at a nominal cost.

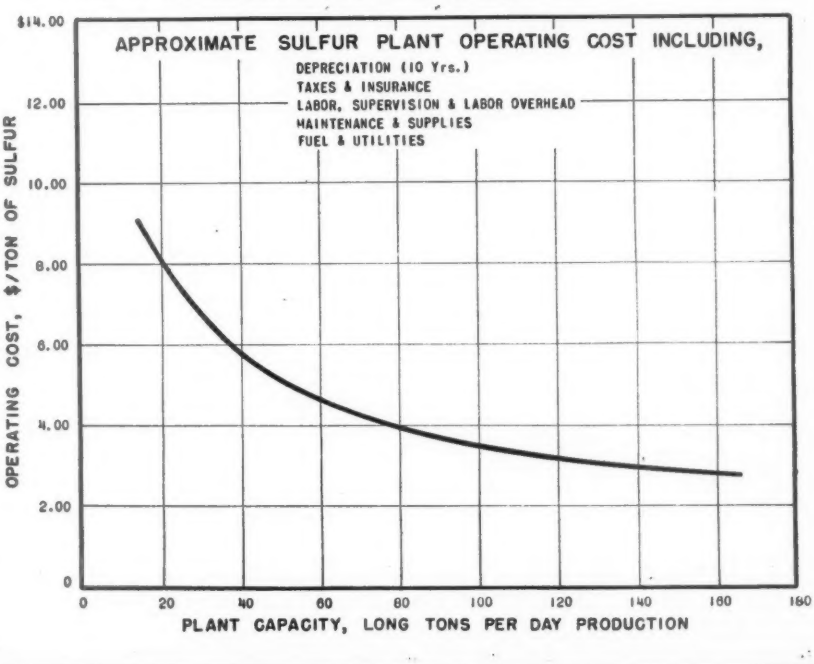
Based upon the assumptions indicated above, there have been plotted in Figs. 3 and 4 approximate investment costs and operating costs for sulfur plants of various capacities at conditions which are favorable for this type of operation.

Fig 3 shows, in addition, actual plant costs for specific plants for operation at a great variety of conditions and locations. Some of the data shown thereon were taken from published DPA certifications lists[18] and it is recognized that such cost figures may include items not specifically pertinent to the actual cost of the sulfur conversion unit itself. All the points, however, indicate the wide spread that may be encountered in investment cost requirements.

The curve in Fig 4 indicates the considerable dependence of operating costs on plant size. In arriving at these operating costs an attempt has been made to use typical values for the factors such as depreciation, taxes and insurance, labor, maintenance, etc. Interest on the investment has not been included as an operating cost as it is believed that such cost estimates are frequently of value in obtaining the effective interest or per cent return on the investment that any particular project may realize. Further, it is apparent that the shape and location of the operating cost curve can be altered considerably by taking depreciation over longer or shorter terms and applying other costs on a different basis. For example, the labor costs have been assumed to include, for small plants, approximately one-half man per shift of operating labor to be made available from labor employed in adjacent operating facilities. This labor has been increased to a full man per shift in plants in excess of 80 tons per day of production. On the other hand, even in a small plant at a somewhat remote location, it may be necessary to employ full time operating labor, in which case the labor costs are increased per ton of sulfur produced.

Similarly, no cost has been assigned to the hydrogen sulfide raw material since it is assumed that the sulfur plant will be owned by the gas treating company. This assumption, of course, will not be valid in many cases, the value of the hydrogen sulfide being dependent upon several factors among which are the plant size and location, and market

FIG. 4. Approximate sulfur plant operating costs.



availability. In some instances it may actually be necessary to credit a small sulfur plant for a nuisance abatement value where atmospheric pollution is a major problem. There have been unofficial reports, however, of payments for raw hydrogen sulfide of amounts in the order of $3 to $4 per ton, indicating that in some instances at least sulfur conversion processes can be economically attractive, even under an appreciable burden for the cost of raw material.

As gas treating plants that would commonly be operated in conjunction with such sulfur recovery plants require large quantities of steam for reboiler duty, credit has been taken at the rate of $0.20 per 1000 lb of 200 psig steam produced by operation of the sulfur plant's waste heat boiler, it being estimated that approximately 5000 lb of such steam will be available per long ton of sulfur produced, assuming that electrically driven pumps and air blower are used in the sulfur plant. Although advantage of this credit may be taken in new installations involving both gas treating and sulfur conversions plant facilities, it may not be advantageous to do so where sulfur plants are built in conjunction with already operating treating and/or other installations.

The operating costs shown are direct costs only, and do not include indirect overhead cost of the parent company, sales and distribution costs, profits or similar items. Such costs, of course, should be considered carefully in a complete profit study for any specific project. Finally, it should be pointed out that the operating costs for an isolated plant or one operated by a company that is separate from the gas treating company would be appreciably higher than for a captive operation in which such overhead costs as indicated above would be more equitably distributed. On the other hand, the impact of such additional costs becomes less severe as the size of the sulfur producing installation increases, and need not be of any significant importance in reasonably large installations.

It might be well at this point to mention a specific process scheme, which could have considerable bearing upon the over-all economics for a particular set of conditions. As pointed out above, the gas treating operations normally preceding sulfur recovery processes frequently require large solution circulation rates with consequent large equipment investment and high steam requirements. In certain specific cases where sour gases bearing appreciable quantities of carbon dioxide in addition to their hydrogen sulfide are treated, and where at least a portion of their carbon dioxide content can be tolerated in the sweet gas from the treater, the selective absorption process utilizing methyldiethanolamine, which has been described elsewhere[19,20], may result in appreciable reduction of these solution rate and steam demands. In addition, there are a few instances in which the hydrogen sulfide content of the residue gas from a normal treating operation is sufficiently low as compared with the carbon dioxide content that the gas stream is difficultly combustible in the furnace operation of the sulfur conversion unit. Again, it may be possible under proper conditions to beneficiate such a stream with regard to hydrogen sulfide content to bring it into the combustible range by the use of the selective treating process on the original hydrocarbon stream. Such process designs should be kept in mind, particularly when considering the construction of an entirely

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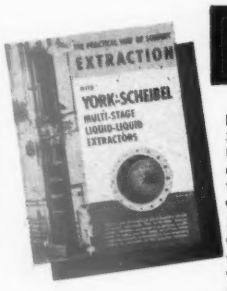

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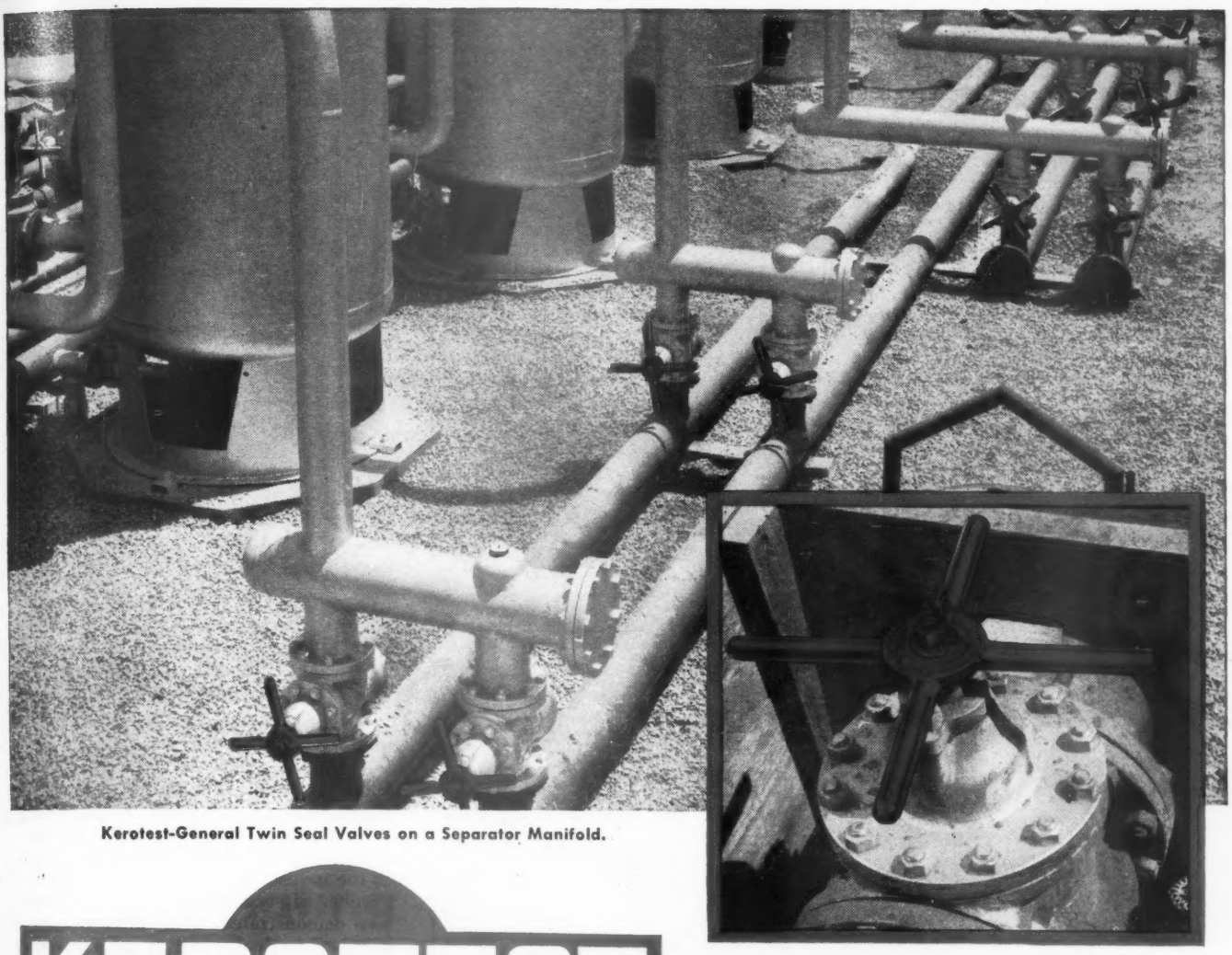
New Petrochemical Processes

Two new processes have been developed recently by oil companies which will contribute to increased production of chemicals from petroleum. Known as hypersorption and chromatography, the processes find application in the separation of gases and liquids, respectively. Since they will increase the output of toluene, benzene and ethylene, they will aid industrial production. Toluene is used in the manufacture of explosives; benzene in many plastics and in other chemicals; and ethylene is primarily needed in manufacture of synthetic rubber.



Kerotest-General Twin Seal Valves on a Separator Manifold.

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NON-LUBRICATED TWIN SEAL VALVES

- ✓ Shuts off Vapor-Tight
- ✓ Easy to Operate
- ✓ No Lubrication
- ✓ Quick Operation
- ✓ No Scoring or Galling

TYPICAL USES

PROPANE	NATURAL GAS
BUTANE	LIGHT HYDROCARBONS
GASOLINE	LIQUID NITROGEN
LIQUID OXYGEN	CARBON DIOXIDE
CRUDE OIL	COMPRESSED AIR

The Kerotest-General Twin Seal Valve is recommended for gas and liquid service in a pressure range up to 5000 psi at 200° F. Seats shut off vapor-tight—no galling or scoring. Operates *without lubrication.* Special trims are supplied for corrosive service.

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new facility that involves both gas treating and sulfur recovery, and may be adaptable in some instances to existing treating facilities where subsequent sulfur conversion is contemplated.

In order to relate the costs discussed above to actual market price, it is necessary to consider the transportation costs. Although water freight in general is usually less expensive than rail, the latter may be competitive for transportation of sulfur from the Gulf Coast to West Coast areas. On the other hand, there are serveral sources of sulfur from hydrogen sulfide to which no water transportation is available, in which actual rail costs must be used in computing ultimate market sales price.

In Part A of Table 1 are shown typical rail freight rates in effect February, 1952 from the Gulf Coast and from certain points in the vicinity of Odessa, Texas for crude bulk sulfur in carload lots to the destinations indicated. In Part B of the same table are shown similar rates which have been established recently for shipment of bulk sulfur from Worland, Powell, Cody, and Thermopolis, Wyoming, to the destinations indicated. The rates shown include all increases to the date indicated, but do not include the 3 per cent transportation tax.

While the present posted price of crude bulk sulfur is $21 to $22 per long ton at the mines in carload lots, it should be recognized that the selling price in any specific area may not be entirely dependent upon these prices, since the demand greatly exceeds the supply in a good many locations. The ultimate value of a particular sulfur producing installation therefore is considerably dependent upon the intended market for the product.

TYPICAL SULFUR FREIGHT RATES

A. From Gulf Coast or Odessa Texas areas to:

	Per long ton
Los Angeles or San Francisco	$12.32
Northwest Coast	16.13
Chicago	9.41

B. From Wyoming areas to:

Los Angeles or San Francisco	$12.32
Northwest Coast	10.98
Lewiston, Idaho	9.86

Conclusions

In conclusion the foregoing may be summarized briefly by observing that the recovery of sulfur from waste hydrogen sulfide gases has achieved a position of importance in the present day sulfur economy. The sulfur conversion process itself is relatively simple, plant investment and operating costs are comparatively small, and the recent advent in the industrial scene of a considerable number of such sulfur conversion units has demonstrated their attractiveness, both economically and as an important measure for the conservation of our dwindling natural resources.

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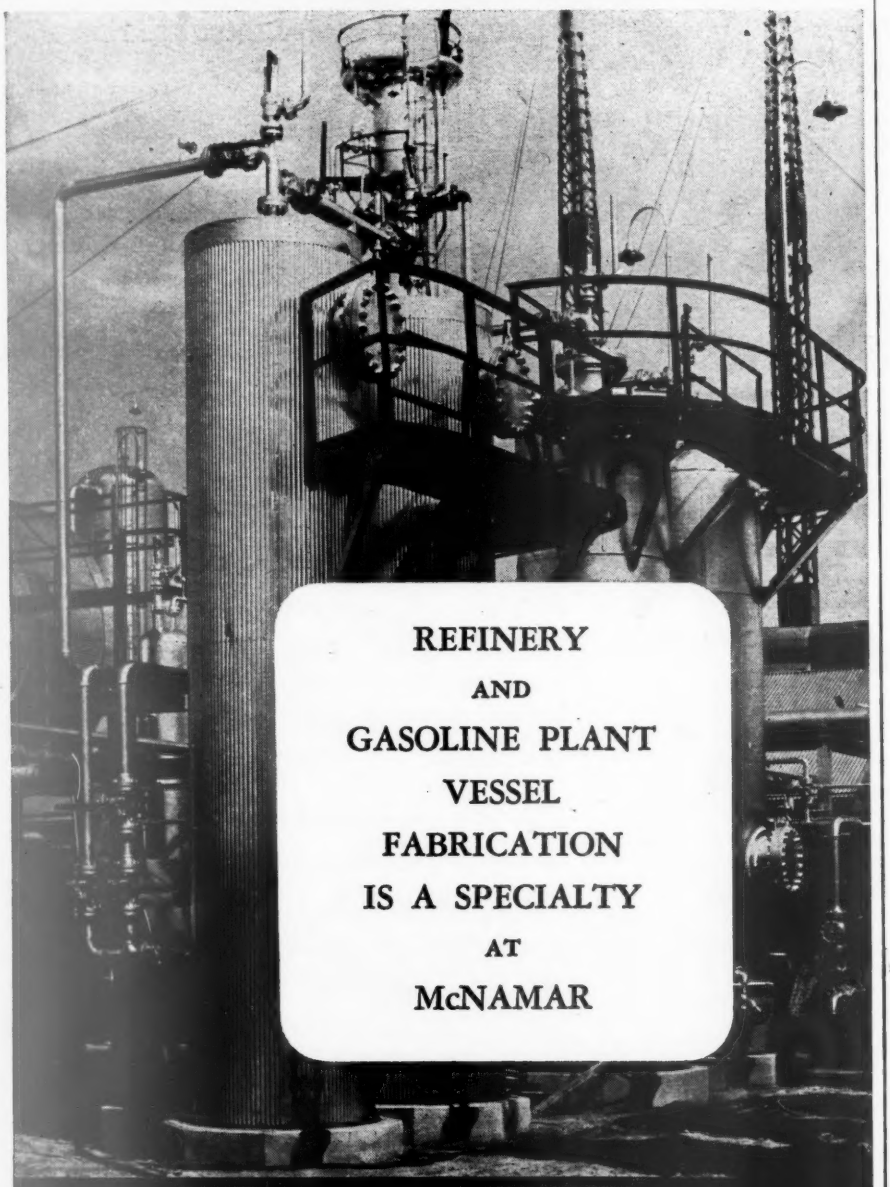

FIG. 1. Three Kewanee boilers insulated with mineral wool cement.

Insulating Cement— A Versatile Heat Saver

Use of modern techniques for applying this plastic-like material rewards the refinery with fast and easy application, clean-cut appearance and effective, lasting insulation

REFINERY management has long recognized the need for and the improvements obtained by insulation. The value of insulation can be measured in many ways —among these, maintenance of proper operating temperatures, reduced power consumption and improved working conditions. In specifying insulation of plant equipment — whether pipes, ducts, flanges, fittings, tanks, or boilers—the engineer or refinery supervisor must decide what equipment should be insulated and, by consulting with a contractor, how the insulation can best be applied. Modern techniques have been devised to apply the various insulation types — many of which are specified because they provide the most effective insulation under particular conditions.

Insulating cement, one of the nine types of mineral wool insulation, is recognized as an effective all-purpose insulation that can be applied alone, or in combination with other forms, to insulate many diverse surfaces, ranging from a small valve to a large storage tank. Other forms of insulation—loose, granulated, felt, blanket, industrial batt, block or board, and two forms of pipe insulation—are designed to fulfill special insulating requirements, e.g., block insulation is a rigid self-supporting form while blanket insulation can be fitted to curvature.

Mineral wool insulating cement is a dry mixture of mineral wool and other ingredients that, when mixed with water to a desired consistency, can be applied to practically any surface that needs insulation. Commercial Standard CS117-49, "Mineral Wool Insulation for Heated Industrial Equipment"*, specifies 0.80 as the maximum thermal conductivity of mineral wool insulating cement at 400 F. This form of insulation can be used on surfaces at temperatures up to 1800 F, higher than any of the other forms.

Table 1 gives the recommended minimum thicknesses of insulating cement for any type or size of equipment at surface temperatures in ranges from up to 200 F to 1800 F. The minimum thicknesses given in the table are those recommended for indoor location; it is suggested that ½-in. added for outdoor locations and ½-in. be substracted in underground applications.

The minimum thicknesses given in the table are intended only as guides to proper thicknesses at the given temperature. The specifier of insulation should carefully consider the factors that determine the proper thickness of insulating cement under particular conditions. Among those listed by Commercial Standard CS117-49 are the cost of heat delivered, the number of hours operated per year, and the effectiveness and the total cost of applied insulation. Other factors that may come into consideration are the maintenance of precise temperature control, protection against damage by corrosion, freezing, or fire, and personal safety of workmen.

After it has been determined what to insulate and what form or forms of insulation will be used, the method of application most appropriate to the form of insulation, the operating temperature, the type of surface and its position must be planned. An unsuitable application technique, whether skillfully carried out or not, does not permit the most efficient performance of the insulation. A method of insulation that is carefully planned and expertly applied takes full advantage of the insulating properties of the materials and, therefore, is by no means considered merely a routine procedure by the alert engineer and the experienced contractor.

Although there are many ways by which cement-type insulation can be successfully installed on refinery equip-

TABLE 1. Mineral wool insulating cement. Recommended* minimum thicknesses.

Temperature—degrees F	Thickness—inches
Up to 200	1
200 to 400	1½
400 to 500	2½
500 to 600	3
600 to 700	3½
700 to 900	4
900 to 1100	4½
1100 to 1300	5
1300 to 1600	5½
1600 to 1800	6½

*Commercial Standard CS117-49, "Mineral Wool Insulation for Heated Industrial Equipment."

Note: Minimum thicknesses are for built-up applications where mineral wool cement is the only insulator. Applied over a primary insulator, thickness is usually ½-in.

*Mineral Wool Insulation Specifications & Standards, compiled by the Industrial Mineral Wool Institute, New York.

EXCLUSIVE

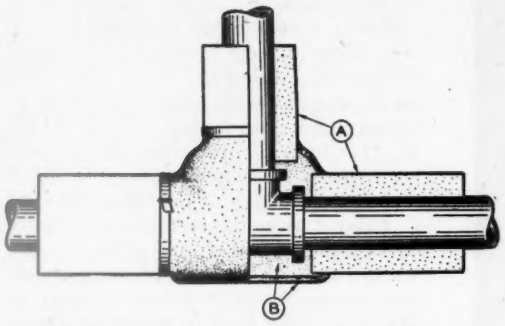

FIG. 2. Cross-section shows an easy method of insulating valves, flanges, and fittings with mineral wool cement.

A, sectional pipe insulation; B, insulating cement covering with specified finish.

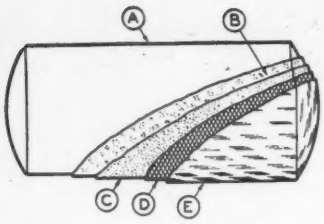

FIG. 3. A, Cleaned bare surface; B, first coat of insulating cement spotted on roughly by hand; C, second coat of insulating cement; D, 1-in. galvanized-wire netting; E, finishing cement or asphaltic finish.

ment, there are three fields of application technique that indicate the elements of good industrial practice and the usefulness of the insulating material. Insulating cement is used in these fields as:

(1) A finishing or auxiliary insulator over another type of insulation.
(2) An insulator that is used in combination with another type of insulation.
(3) An insulator that is used alone.

An Auxiliary Insulator

Insulating cement is used in a large number of applications in which it is not the primary insulator. Another type of insulation—felt, blanket, industrial batt, and block or board—is first secured directly to the heated surface to be insulated. The insulating cement is trowelled directly onto the primary insulation or, when an extra firm grip is needed, over wire netting attached over the primary insulation. The insulation manufacturer provides blanket insulation with a selected type of expanded metal lath on one side and wire netting or lath on the other.

As an auxiliary insulator, the purpose of mineral wool cement is to provide a tightly-sealed insulating layer—by covering all corners and joints of the sections of primary insulation—and to give a suitable base for finishing cements or other finishes such as canvas and asphaltic mastic. In these applications, the insulating cement is usually ½-in. thick or less and is applied in two layers; a ½-in. thickness, for example, includes a ¼-in. layer smoothly trowelled over a ¼-in. layer that has been allowed to dry thoroughly. Portland cement may be added to the insulating cement for the second layer to give a smoother, harder finish where the full insulation quality of the cement is not required. It is clear that, when used as an auxiliary, mineral wool cement, although an insulator itself, is actually applied to seal and finish another form of insulation that does the bulk of the job.

The method used to insulate three small boilers illustrates the auxiliary uses of insulating cement as applied over mineral wool board sections. The three Kewanee gas-fired boilers in Fig. 1 provide low-pressure steam at 5 psi. The primary insulation, 24 by 48-in. mineral wool board sections, two inches thick, was fastened with 14-gage galvanized iron wire to nuts welded to the boiler surface on 2-ft centers. The board sections were staggered and firmly butted together to provide as tight an insulation cover as possible.

Then, 1-in. galvanized wire mesh was stretched over the mineral wool boards and wired to the wire securing the boards. The wire netting was applied over the mineral wool boards to provide a good gripping surface for the cement. A ⅜-in. thickness of mineral wool cement was first trowelled into the wire netting and allowed to dry. The second ⅜-in. coat, 5 parts insulating cement to one part Portland, was then applied to provide a hard, smooth exterior. The installation was completed by pasting 10-oz. canvas over the second layer of cement. After glue-sizing the canvas, two coats of paint were supplied.

The insulation on these boilers was designed for long service without periodic maintenance. The insulating cement is not visible in Fig. 1, and is only a part of the insulation, but it contributes directly to the efficiency, appearance, and useful life of the boilers and the primary insulation.

An Insulator in Combination

In combination with one or more other types of insulation, mineral wool cement has proved to be extremely useful in insulating sometimes small, often irregularly-shaped surfaces and equipment such as valves, flanges, and fittings. The types of insulation most commonly used with insulating cement in these applications are molded-type pipe covering, blanket, block, and felt.

The most common techniques are illustrated by the insulation of the Tee-joint in Fig. 2. The three arms of the Tee-joint have been covered with mold-

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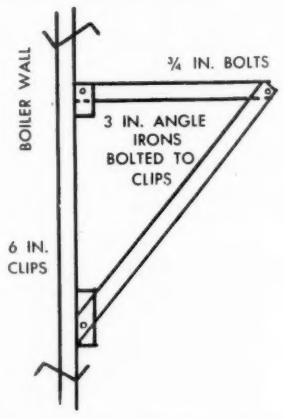
PLANT AID

Permanent Scaffold Brackets on Boilers* J. G. FIELDS

Older plant practice has been to have carpenters build temporary inspection scaffolds at each boiler at, say, 3-month intervals for the use of inspectors and repairmen. Permanent brackets, installed as indicated in the drawing,



speed up the installation of scaffolds and the inspection-repair work, reducing manhours considerably. Six-inch clips, two in number, are attached to the boiler wall as shown, to which are bolted two 3-in. L-irons, which are also bolted together so that one is horizontal and the other at an angle as a brace.

*This plant aid submitted through courtesy of the Humble Oil and Refining Company's Coin-Your-Ideas Plan.

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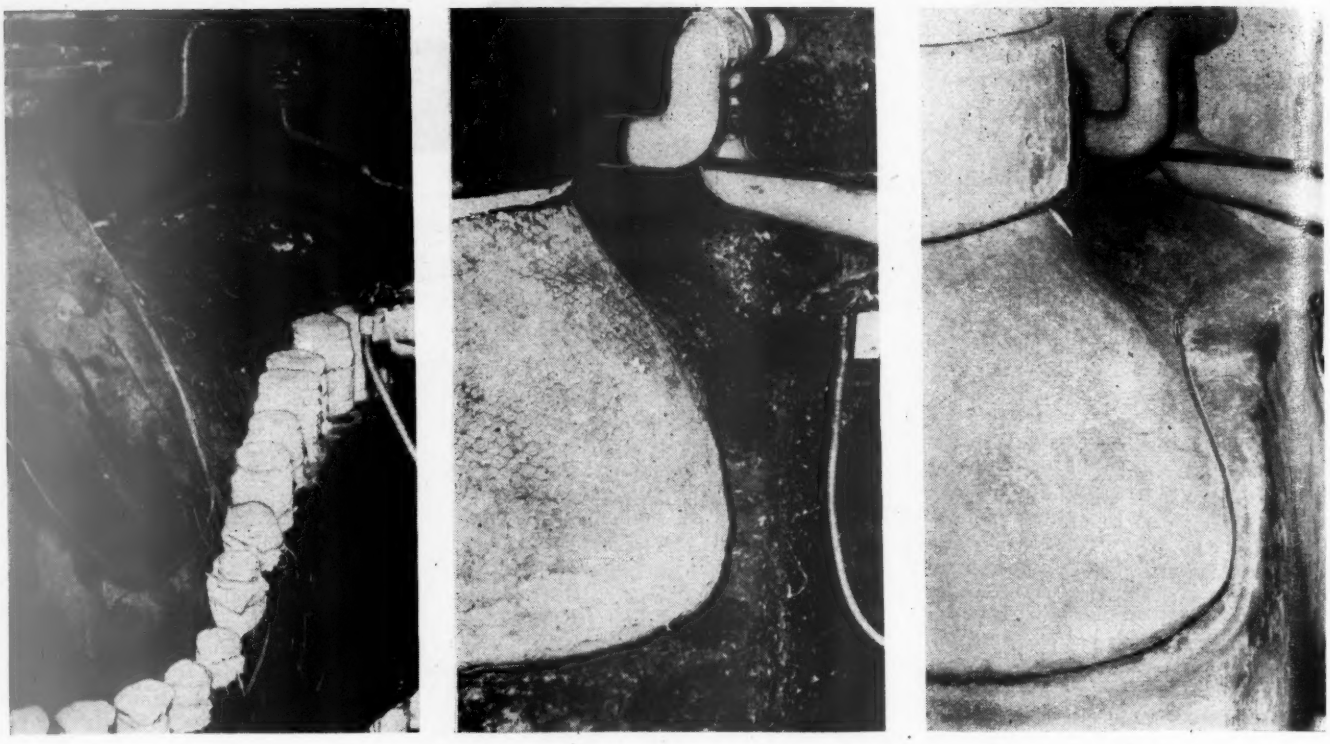


A B C

FIG. 4. Method of insulating an irregular surface, a steam turbine. Three layers are employed with wire netting between. Note rolls of asbestos cloth tied around large case bolts to facilitate case top removal for internal maintenance.

ed-type mineral wool sectional pipe insulation (A) as close to the intersection as possible. Insulating cement and finishing cement, (B) in the figure, are then applied to conform to the contours of surrounding pipe insulation. In order to insure a firm seal, the insulating cement is built up in successive layers, each no greater than ¾-in. thick, and each layer is allowed to dry thoroughly before applying the next. A thin coat of finishing cement completes the job.

Insulation on valves, flanges, and fittings should be no less carefully planned and applied than on larger equipment where heat loss is more apparent. Insulated pipe lines on which valves, flanges, or fittings are left uninsulated are still losing heat at these points; more-than-necessary power consumption and higher fuel costs are the results.

The Only Insulator

Mineral wool cement in its third field of application—as the sole insulating material—is installed on most types and sizes of surfaces but finds particularly wide use on plant equipment where irregular hard-to-get-at surfaces make the installation of other types too difficult or impractical.

On curved or flat metal surfaces, insulating cement is built up in separate layers. The first layer is usually spotted on by hand over the surface and into corners and joints. When the total insulation thickness exceeds 2-in. or when the material is to be applied on the underside of equipment, it is recommended that galvanized wire netting be applied between every second coat. If layers thicker than ¾-in. are necessary, wire netting should be applied between each coat. The wire netting is stretched tightly over the dry cement and secured with 16-gage galvanized wire.

In Fig. 3, the sequence of steps in applying mineral wool cement in layers ¾-in. thick or less on a cylindrical tank is demonstrated. The 1-in. galvanized-wire netting covering the two layers of cement is followed by the application of finishing cement or asphaltic finish (E). The use of wire netting between alternate layers of cement is particularly important where equipment is subject to vibration; the possibility of cracks and splits in the insulation is eliminated.

For example, engineers specified mineral wool cement to insulate the irregular surfaces of the turbine in Fig. 4. Sequence photos A, B, and C in Fig. 4 are close-ups showing the top of the high-pressure section of the turbine, which drives a 60,000-kva generator. In the background is the highest temperature zone of the turbine at about 950 F.

Mineral wool cement is applied to the turbine in two layers with 1-in. wire mesh secured by tie-wires over the first layer as additional support and as a key for application of the second layer. In the sequence photos, the three-step installation goes from bare surface and tie wires (A), to first layer and wire mesh (B), to second layer (C), which completes the job.

In photo A, the 16-gage copper-weld tie wires are twisted through ¼-in. nuts welded to the turbine surface on about 12-in. centers. Asbestos cloth has been wrapped and tied around the large bolts to facilitate later removal of the top section of the turbine for internal maintenance.

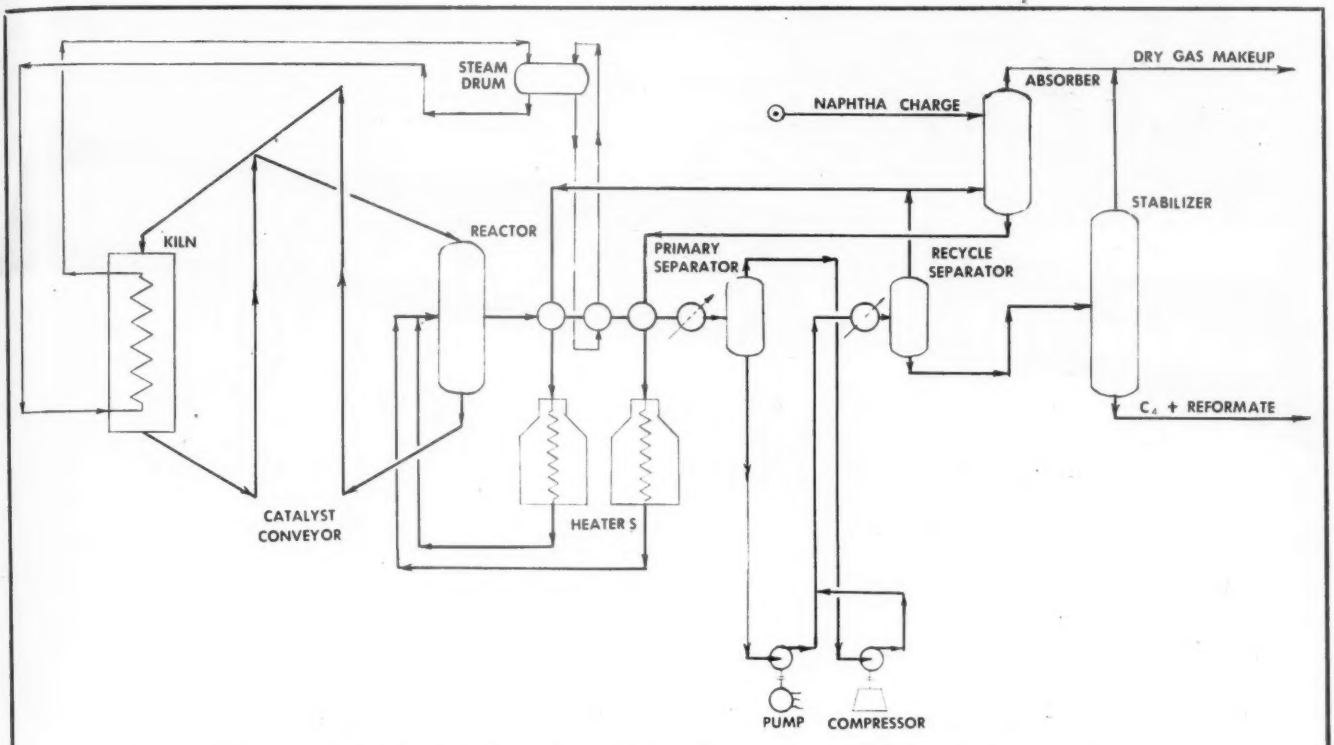
The first coat, 3-in. thick, of mineral wool cement (Photo B) is next trowelled smoothly over the surface and around the cloth-covered bolts. The tie wires can be seen protruding from the wet cement in the lower right. The dried mineral wool cement on the left in Photo B has already been covered with wire mesh stretched to fit tightly and fastened with the tie wires. For best results, the first layer should be completely dry before application of the second layer.

In photo C, the second layer has been carefully trowelled into the wire mesh and allowed to dry thoroughly. The thickness of the second layer has been varied from 1-in. to 3-in. according to the surface temperatures on particular sections of the turbine. In the highest temperature zone, the second layer is 3-in. thick to provide a total of 6-in. of mineral wool cement. Note that the bolts have been completely covered to form a smooth, unbroken Btu-barrier.

To reach the bolts for maintenance of the turbine, it is only necessary to chip away the mineral wool cement around the bolts and remove the cloth covers. The nuts are then taken off and the top of the turbine lifted. When maintenance is completed, the turbine top is simply bolted back into place and the bolts re-insulated with a small amount of mineral wool cement. The major portion of the insulation jacket on the turbine remains intact with no damage.

After insulation is completed, a steel housing is installed over the turbine.

* * *



Diagrammatic flowsheet of Thermofor catalytic reformer, Socony-Vacuum Oil Company, Inc.

TC Reforming Process Regenerates Catalyst

Outstanding feature of the TCR system is its ability to obtain highest octane rating increase under severest conditions

INTERESTING indeed is the information released recently that the Thermofor catalytic reforming (TCR) process, youthful runningmate of the Thermofor catalytic cracking (TCC) process, developed and licensed by Socony-Vacuum Oil Company, employs a regenerative system akin to that used for the TCC process. This is in contrast to other catalytic reforming processes, which, according to announced data, do not regenerate the catalyst in the reforming system but depend on the small carbon laydown on catalysts, most or all containing platinum as the most active agent, which possess high activity throughout a long period, but with no regeneration.

An outstanding feature of the TCR system and its regeneration principle is that it can be operated under very severe conditions to obtain the highest octane rating increases possible. As coke deposit is low, and when operating on heavy carbon-producing stocks, catalyst can be regenerated at the optimum rate for top efficiency, the efficiency of the process is essentially independent of coke deposit properties of the charge.

In the TCR process the catalyst moves downward, by gravity in moving-bed fashion through the reactor, and thence through the regenerator where coke is burned off in conventional manner. Regenerated catalyst is transferred to the reactor by suitable means, presumably by air or gas-lift or bucket-elevators, similar to that employed in the TCC process. Recycle gas rich in hydrogen is circulated and recycled with the charge.

Proposed reactor pressures may range from 100 to 200 psig, according to advices received, in contrast to the 700-800 psig employed in some other operations. The catalyst is a cogelled chromia-alumina catalyst of rugged type, "put up" in bead form similar to the form employed largely in the TCC process. Because of the regenerative feature of the process, the widest boiling range charge stocks can be processed advantageously. Similarly, under any given set of conditions, the rate of regeneration of the catalyst is lower than is the case with cracking. In fact the amount of catalyst circulated is quite small, of the order of 10 per cent of that circulated in present-design air-lift TCC cracking units. When processing high sulfur stocks, the sulfur is practically all eliminated from the system with the hydrocarbon product as H_2S, which can be neutralized or can be recovered in conventionally employed processes as elementary sulfur.

Referring to the simplified flowchart herewith, it is noted that naphtha charge enters an absorber and meets hydrocarbon and hydrogen gases from the recycle separator, overhead from which is dry make-gas. Charge is then heated in a furnace, as is the stream of recycle gas from the separator, and the two streams join just before entering the reactor. The product stream goes to a primary and a recycle separator after exchanging heat with incoming charge and with recycle gases, is stabilized in conventional manner, and the stable product, which includes butanes and heavier, is removed from the system. ★

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△p/tray	.....	1.38" H_2O

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Density #/CF	38° API (lean)	2.43 #/CF

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AUTOMATIC WATER TREATMENT FEEDER*

CHAS. W. MILLER†

Purpose: To inject controlled amounts of chemical solutions at regular intervals.

The mixing vat is sized for a week's supply of solution and calibrated so solution concentrations are easily controlled. The solution may be mixed and tested while continuing the charge from the feed vat. Air agitation insures thorough mixing.

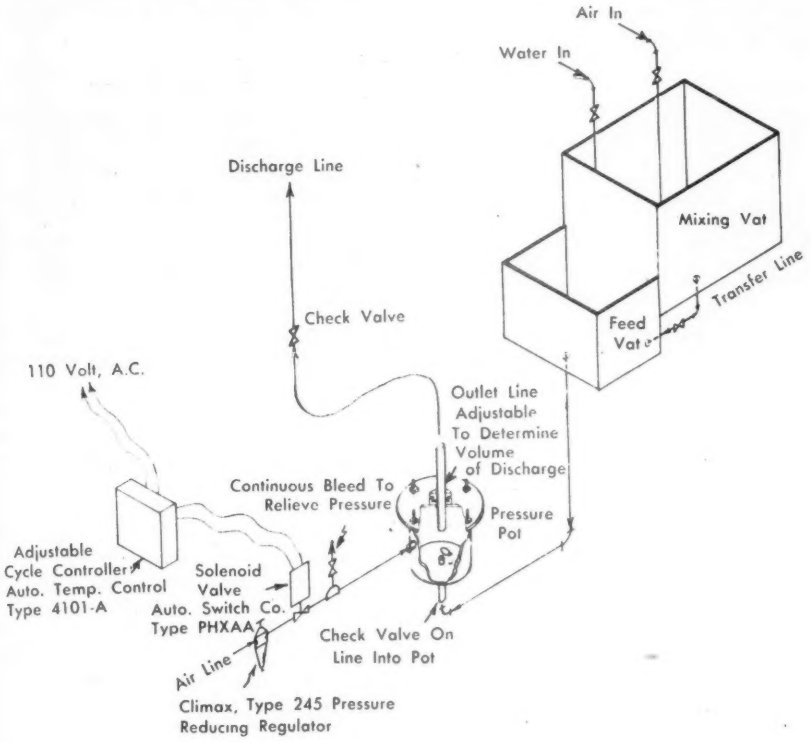
Solution flows by gravity from the feed vat through a check valve into the pressure pot. At selected intervals, air pressure forces the solution through the discharge line to the water to be treated. The volume of solution discharged from the pressure pot may be varied by raising or lowering the outlet line through a stuffing box.

The electrical time cycle controller, at predetermined intervals, opens the solenoid valve admitting air pressure to the pressure pot for a selected length of time. The air pressure required is controlled by the pressure reducing regulator. The continuous bleed vents the air pressure and enables the pressure pot to refill.

By utilizing the many adjustable features, (that is, by varying the concentration of the solution in the calibrated mixing vat, the volume of discharge from the pressure pot, the number of "blows" per hour), uniform treating is possible under a wide range of operating conditions.

This automatic water treatment feeder is inexpensive, simple in construction, easily adjustable, and offers trouble-free operation. The hazards of chemical handling are reduced, and the waste of chemicals from mixing and non-uniformity are at a minimum.

Use of the feeder for six years has proved its practicability. The treating results obtained are superior to those obtained by the usual methods of adding chemical treatment. The original cost is insignificant when considering the savings in man hours and in chemicals.



*NGAA Grand Prize Winner:
†Plant superintendent, Midland Gasoline Company, Conroe, Texas.

Micarta Piston Rings for Pumps§

Due to poor suction by pump-out pumps on chilling-and-holding compressors in a lubricating oil plant propane system excessive downtime on compressors may be experienced. This condition arose from the fact that in the liquid end the pistons are packed with a material such as Rockhard packing, without expanders to maintain contact with cylinder walls. A solution of the problem proved to be the removal of the packing, installation of ring lands and fitting pistons with Micarta rings and expanders. This system has reduced pump downtime considerably.

W. F. ZAWATSKY, E. S. GREER

Elimination of Excess Pump Packing§

To augment or supplement the work of plunger lubricators on polymerization unit light oil pumps and to reduce packing leaks, two small, air-motor-driven oil pumps, attached by means of tubing, pump extra oil into the packing glands to add to that supplied by the regular lubricator. This additional lubrication keeps the packing pliable, reduces the number of packing leaks and reduces repacking needed, from seven per month to one per month. The saving in process time, repair man-hours, materials and leak hazards results in appreciable annual savings.

§These plant aids submitted through courtesy of the Humble Oil and Refining Company's Coin-Your-Ideas Plan.

TAR HEATER*

H. B. BROWN†

Purpose: Heating tar prior to application to underground lines.

A tar heater was constructed for the purpose of melting tar prior to application to underground lines. The heater is on a trailer and can be moved to the job location for convenience. The body of the heater is constructed of 24 in. pipe and has a capacity of approximately two barrels. A 10-in. opening is provided in the top to put the tar in the heater. The molten tar is withdrawn from the bottom through a two inch valve. This valve is placed in the back of the firebox to prevent the tar from hardening and closing the opening. The tar is agitated while being heated by the use of a paddle attached to a crank, in the same manner as an ice cream freezer.

The firebox was constructed by welding a piece of 18-in. pipe horizontal under the 24-in. pipe, the flue is of 8-in. pipe. Heat is furnished by two jet type burners. Kerosene was found to be the best kind of fuel to use for heating. The fuel tank is pressured by means of a hand pump to a pressure of approximately 50 lbs for starting purposes. It was necessary to put impingment plates in front of the burners to insure continuous ignitition of the fuel. This heater has proved to be a great time saver in the application of pipe line enamel.

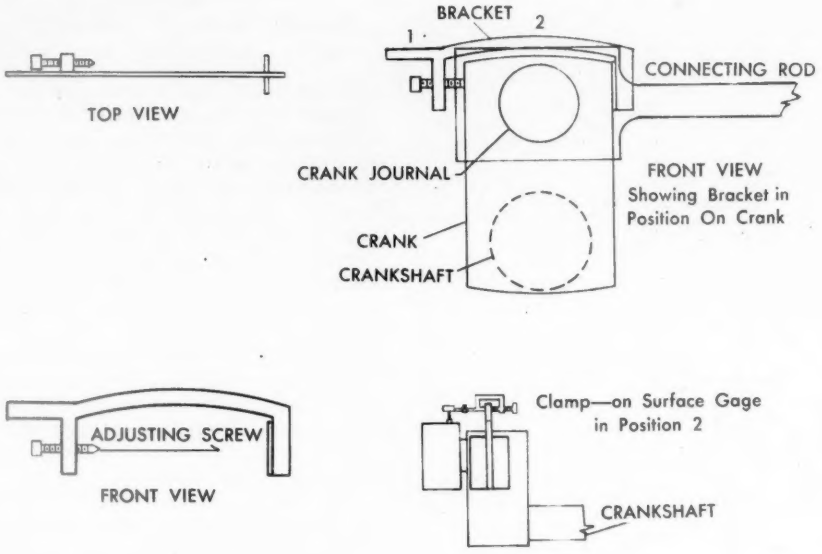
*NGAA Honorable Mention—Class D.
†Construction foreman, Arkansas Fuel Oil Company, Greggton, Texas.

CRANK BEARING CLEARANCE GAGE SUPPORT BRACKET*

QUINTIN H. GAMBRELL†

Purpose: To support a surface gage over a crank bearing in order to measure the bearing clearance.

The support bracket is fashioned in the general shape of a "C" clamp, with a rectangular steel plate opposing a screw for tightening across the crank. The bracket is fabricated from ¼-in. steel plate. This kink is designed for use with a standard surface gage graduated in one-thousandths of an inch (.001 in.), to measure clearance on crank bearings where there is not enough room to use a feeler gage.



To measure the clearance, the surface gage is clamped to the top of the arch of the bracket with a universal clamp and a small "C" clamp. With the crank in a vertical position, the surface gage is set rigidly against the top of the connecting rod and the initial reading taken. Then by use of an overhead chain hoist, the connecting rod is elevated carefully until the bearing is in contact with the under side of the crank journal, and a final reading is taken. Difference between initial and final readings is the clearance.

Clearance in the horizontal direction may be measured similarly by moving the surface gage to Position 1 as shown on the drawing, and setting the gage shaft against the end of the connecting rod bearing cover. Then by using a flywheel jack to oppose a bar through the spokes of the flywheel, a rocking motion may be created with just enough magnitude to move the bearing through its clearance and not disturb the position of the crank. Readings are taken in the same manner.

This device was designed specifically for use on Type GMB Cooper-Bessemer Direct-Connected Engine-Compressor Units.

*NGAA Second Prize Winner—Class "A".
†Plant repairman, Magnolia Petroleum Company, Kilgore, Texas.

Stainless-Steel Paint

Stainless-steel paint! Flakes of stainless steel mixed with suitable vehicle has been found a very desirable paint for certain electrical equipments. For mobile transformers, where a good appearing, gray, durable, matte finish is desired, the stainless-steel paint is proving just the right answer and is now Westinghouse standard for the purpose.

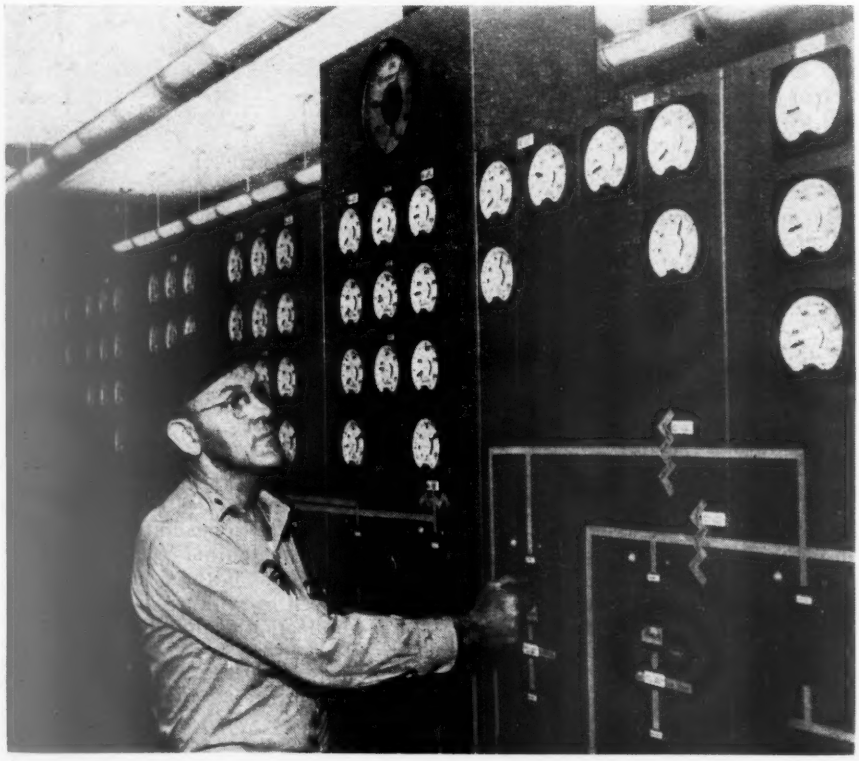
It is yet too early to make full evaluation of stainless-steel paint. It will probably have excellent resistance to certain types of corrosion. For example, stainless steel is able to withstand alkaline atmospheres, which aluminum paint cannot. Hence, around plants making or using alkali, transformers and other equipments may be better protected with stainless steel pigments in the final coat. Such is being investigated.

Stainless-steel pigmented paint appears to be particularly good for industrial atmospheres. Applied to distribution transformers installed opposite a steel plant, the finish still looks perfect after a year and half exposure. It does not appear to show the color changes normally experienced in the chalking of standard gray outdoor finishes.

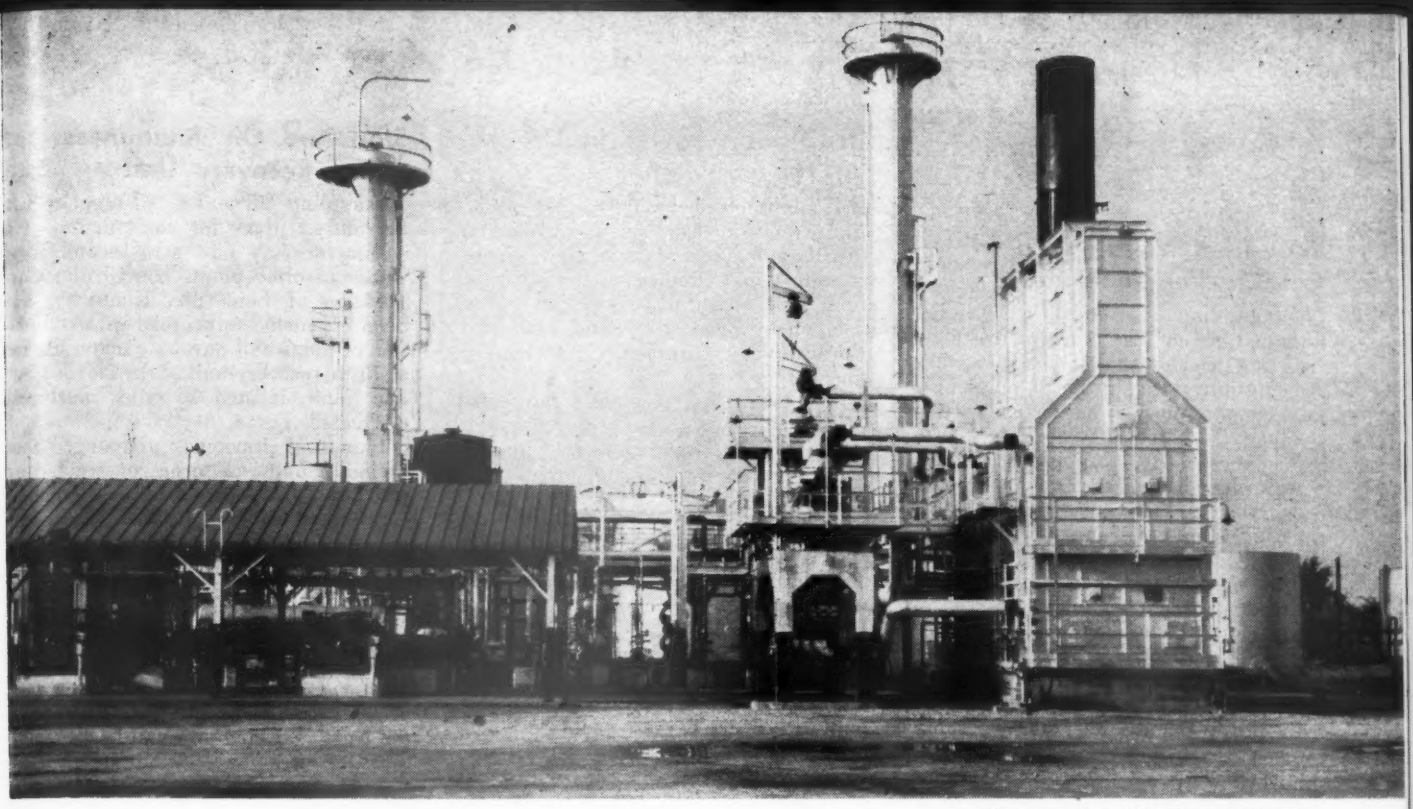
Circular-Scale Design And Full-View Dial

Usually, engineering ideas, no matter how good, take time—years—to spread into the various forms to which they are applicable. In the instrument field are two that have taken a much faster pace. These are the circular-scale design and the full-view dial. The first came during World War II, as a requirement of the U. S. Navy, and the second was announced only a little more than a year ago.

Both received such immediate acceptance that instrument designers have been hard put to it adapting the ideas to the many essential functions required of instruments—and there are literally thousands of varieties, each of which is a design problem in itself. Last year, for example, the continued expansion of circular-scale instruments included a-c wattmeters, several d-c types, high-voltage d-c types, and position indicators. The full-view feature has been extended to the entire family of switchboard instruments and to those designed for rear-of-board mounting.



At left is circular scale full-view instrument.



Platformer of Mid-West Refineries.

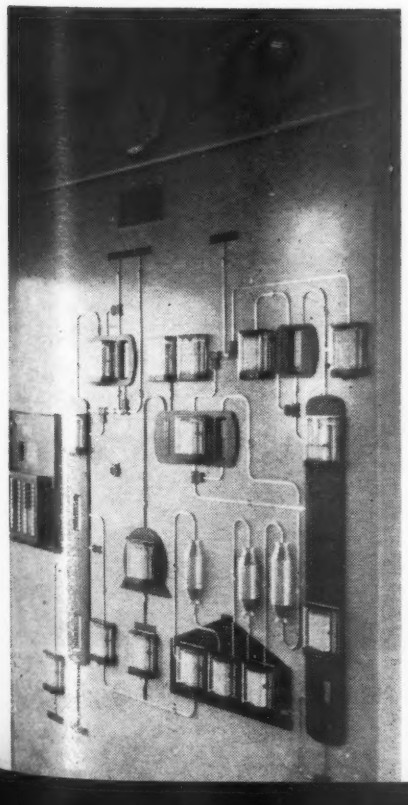
P 721.35

Michigan Refinery Yields 35-40% Aromatics

J. C. ALBRIGHT

MID-WEST REFINERIES, INC., Alma, Michigan, has met the requirements for higher octane motor fuel by the addition to the plant at Alma. During 1951, the entire distillation facilities were overhauled, revamped, and enlarged by the construction of a third independent topping plant. In addition to the conventional production of heavy fractions — gas oil, domestic fuel oil, and residuum —the combined production of the three units provide ample, straight-run for subsequent processing in the new platforming unit. This platformer was designed for an average daily throughput of 1750 bbl with a conversion of better than 90 per cent to produce a gasoline having an F-1 octane of around 80. This, of course, is to be blended with thermal cracked gasoline, straight run and combinations of gasoline stocks to supply a motor fuel with superior operating characteristics.

Control panel in Platformer.



An experimental run was made to determine optimum throughput values, a run extending over an 8-day period. During this experiment on the Platformer, the straight-run gasoline had an average gravity of 60.5 API, and a boiling range from an IBP of 101.5 F, to an EP of 299.5 F, on an Engler laboratory test. As the heart cut of straight-run gasoline is the type of stock for Platformer charge, the product was prefractionated to remove the top and bottom, leaving a material having an initial boiling point of 159 F, and an end point of 390 F. The average gravity of this stock during the 8-day run was 55.2 API. Lab reports show that the 50 per cent over of the product during the run was 275 F, Engler.

During the run, the charge was varied to the platformer from 1680 bbl per day, to a maximum of 2120 bbl per day. The following tabulation indicated operating conditions and the results during the eight-day test run:

24 hr Ending 7 AM...	8-1	8-3	8-5	8-8
Flows—BPD (MSCF/D)				
Reactor charge.....	1638	2120	1893	1900
Platformate.....	1505	1883	1709	1738
Loss (Unconverted)	133	237	184	162
Conversion.....	92%	89%	90.5%	91.5%
Separator gas.....	610	734	587	493
Stabilizer gas.....	236	486	523	383
Temperatures, F				
#1 Reactor inlet....	902	915	920	911
#1 Reactor Δ T....	—24	—21	—25	—23
#2 Reactor inlet....	919	919	920	910
#2 Reactor ΔT.....	—42	—45	—39	—3[illegible]
#3 Reactor inlet....	913	918	920	905
#3 Reactor Δ T....	—16	—23	—13	—11
Total Δ T.....	—82	—99	—72	—66
Pressures, PSIG.....	8-1	8-3	8-5	8-8
Comp. discharge...	723	745	757	753
#1 Reactor inlet....	711	728	744	745
#3 Reactor outlet...	685	693	702	702
Separator.....	652	665	673	672
Stabilizer.....	284	180	176	170
Analyses				
Pre. feed API.....	60.2	60.3	60.9	60.6
Boiling range F				
IBP.....	101	98	102	105
EP.....	402	393	397	406
Reactor charge				
API.....	59.7	55.9	55.7	55.8
IBP.....	184	180	180	172
50%.....	281	274	274	270
EP.....	392	390	393	389
Platformate API...	54.6	55.5	56.4	57.0
IBP.....	117	108	105	107
EP.....	402	400	412	406
%212.....	33	36.5	38	36
RVP.....	4.1	5.4	6.5	5.8
% aromatics.....	38	38	38	36
f-1 clear.....	79	77	80	78.4
f-1 3 cc TEL.....	92.5	91	93.8	92
Miscellaneous				
$\%H_2$ in recycle.....	82	83	78.7	77.6
Gr H_2S/100 SCF...	....	....	....	....
Gas recycle rate MMSCF/d.....	10.9	10.9	11.8	11.7
H_2/HC Mol ratio...	6.8	6.0	6.2	5.9
Hours on stream.....	(39.1)	(43.9)	(48.6)	(56.3)

EXCLUSIVE

NEWS

Expanded Metal Used in Cat Cracker Separators

A new kind of stretched steel lining designed to cut cat cracking costs by reducing deterioration of cast rafractory is being introduced at the Baton Rouge, Louisiana, refinery of Esso Standard Oil Company.

When cast refractory is put into 10 new cyclone catalyst separators there, it will be applied over Wheeling Corrugating Company's expanded metal to hold it permanently in place. Expanded metal—solid sheet steel that has been slit and stretched on huge presses—is used to form the base on which abrasion-resistant refractory is cast after the cyclone vessels have been erected at the refinery site.

In the regenerator operation, some catalyst is entrained from the dense catalyst bed by the flue gases. The flue gases are therefore passed through a battery of 8 or 10 cyclone separators installed in the top of the regeneration vessel in order to affect recovery of the catalyst. Inside the cyclones, the high-speed stream of flue gas and catalyst follows a descending helical path. This separates the solid catalyst particles, which fall to the bottom for reclaiming and re-use, while the hot gases pass out through a central pipe.

Distillation Tower in Use At Torrance Refinery

It might have been in Moscow, but it's in Torrance instead. This 157-ft, 200 ton distillation tower, shown below in process of being lifted to an upright position, will begin making aviation fuel components soon at General Petroleum Corporation's Torrance, California, refinery.

The tower was originally fabricated during World War II for a refinery in Soviet Russia. The Lend Lease shipment was cancelled in 1945 and for over six years the tower lay unused.

Atlantic Plans 2 New Units

Contract for design and construction of two new units at Atlantic Refining's Point Breeze (Philadelphia) refinery has been let by that company to M. W. Kellogg Company of New York. The fluid (Orthoflow) catalytic cracking unit will be the largest of its design in the world. The alkylation unit will use sulfuric acid as catalyst in a 3500 bbl per day capacity operation, making aviation alkylate and employing the new cascade type reactor. The cat cracker will use the combined reactor-regenerator single converter design, claimed to be less costly than the older side-by-side design. Six other similar Orthoflow units have been built or are building. Construction of these units will begin this spring and will be completed sometime in 1953, it is planned.

Stanolind Oil Announces Sulfur Recovery Unit

Stanolind Oil and Gas Company has announced plans for construction of a sulfur recovery unit at a second West Texas gasoline plant. The Girdler Corporation of Louisville, Kentucky, has been instructed to proceed with completion of plans and purchase materials for a sulfur recovery unit at the North Cowden plant, located 15 miles northwest of Odessa, Texas.

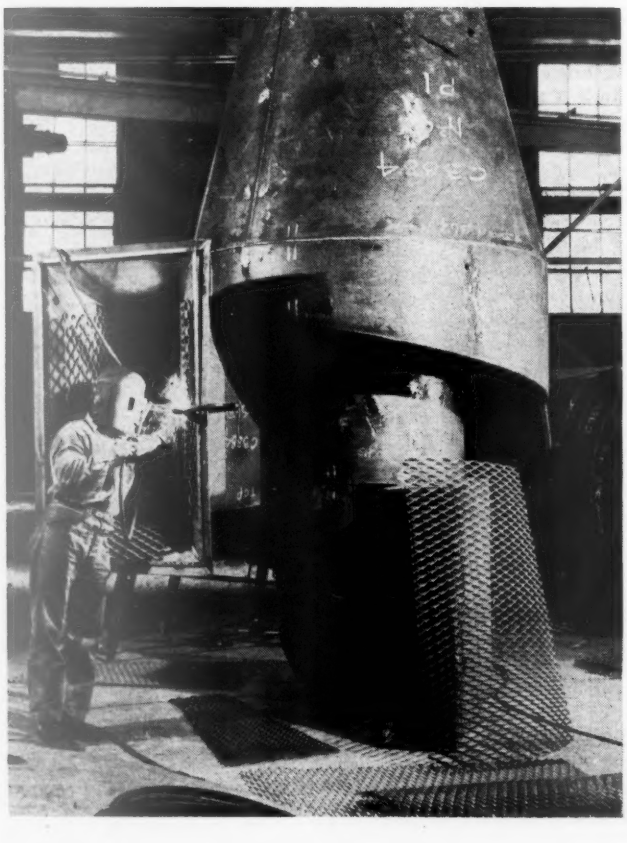
Stanolind previously announced that a similar unit was to be constructed by the Fluor Corporation of Los Angeles, California, at Slaughter gasoline plant near Sundown, Texas. Both North Cowden and Slaughter are operated by Stanolind for groups of owners.

Fluor Corporation has completion scheduled for September of this year. When completed, the Slaughter unit will have a design capacity of 49 long tons of sulfur daily. The design capacity of the North Cowden unit will be 17.7 long tons per day.

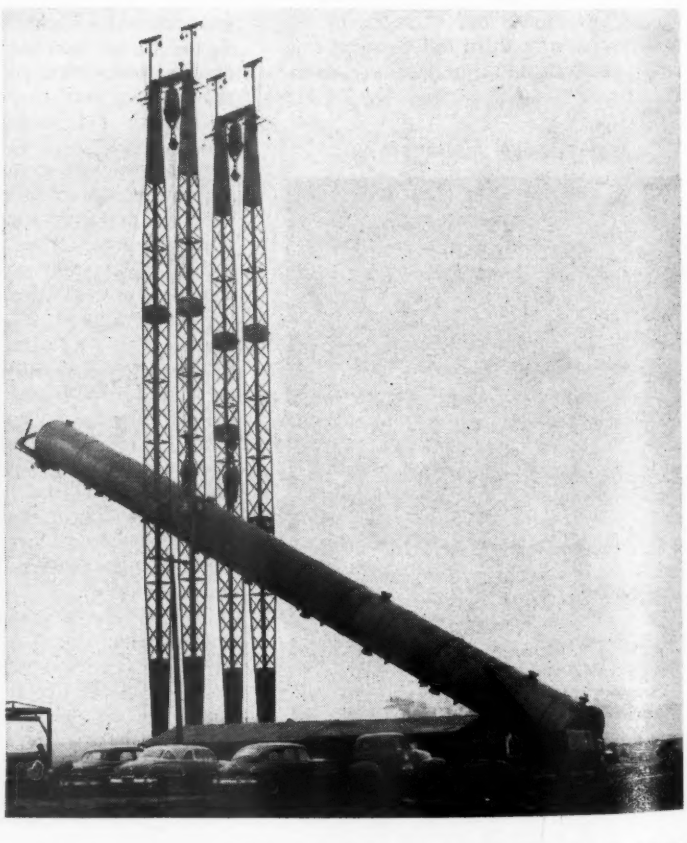
B-A Refinery Awarded

The staff of the British American Oil Company's refinery in Calgary, Canada, has completed 365 days without a lost-time injury. This is the third time in six years that the staff of 118 have become eligible for the company president's award of one full day's pay in recognition of their contribution to B-A's safety program.

Welder tacks Wheeling Corrugating Company's expanded metal inside rectangular inlet of cyclone catalyst separator to be installed at Baton Rouge refinery of Esso Standard Oil Company.



Lifting the distillation tower at the General Petroleum Corporation's refinery at Torrance, California. Tower was originally made to Lend Lease Russia.



European Refineries Show Increased Output Rates

Anglo-Iranian Oil Company's associated companies have reported progress at the following European refineries:

Antwerp, Belgium, refinery, which began production last October, is now producing at a rate approaching 40,000 bbl a day. This refinery is jointly owned by Anglo-Iranian and Petrofina.

Porto Marghera refinery, Venice, Italy, has production rate of 25,000 bbl a day—1951 output was 13,500 bbl daily.

Dunkirk production rate has risen to 40,000 bbl a day from last year's production of 12,400. A new distillation unit and ancillary unit were commissioned last October.

At Hamburg, Germany, Anglo-Iranian's Eurotank and the Schindler refineries, now show a combined production rate of 16,400 bbl a day. Their 1951 rate was 13,500 bbl a day.

API Compounds Available

The four compounds listed below are newly available as American Petroleum Institute Standard samples. A list of the 197 compounds now available may be obtained on request to Carnegie Institute of Technology, Attention of Frederick D. Rossini, Department of Chemistry, Pittsburgh 13, Pennsylvania.

Orders for samples should be accompanied with full payment in advance, with check made out to the Carnegie Institute of Technology.

Each order should give the following information for each compound wanted: Name of compound, number of the sample, size of unit, number of units, price per unit, total cost.

Standard sample No.[1]	Compound	Amount of impurity[2]	Volume of unit[3]	Price per unit
		mole per cent	ml (liquid)	$
1010-5S	1,1,2,2-Tetramethyl-cyclopropane	0.04±0.03	5	35.00
1011-5S	5-Methyl-1-hexene	(0.20±0.15)[4]	5	35.00
1012-5S	3-Ethyl-2-pentene	(0.20±0.15)[4]	5	35.00
1013-5S	2,2-Dimethyl-cis-3-hexene	0.16±0.12	5	35.00

[1] The designation "-5S" following the sample number indicated a sample of 5 ml sealed "in vacuum" in a special Pyrex glass ampoule with internal "break off" tip.

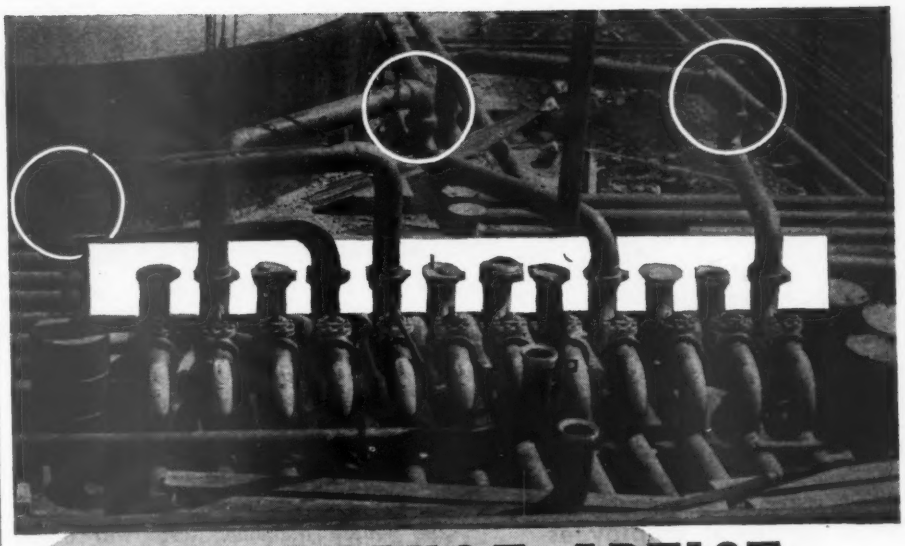
[2] The purity has been evaluated from measurements of freezing points in accordance with the method and procedure of the American Petroleum Institute Research Project 6, as described in J. Research Natl. Bur. Standards **35**, 355 (1945), and Anal. Chem. **20**, 410 (1948), unless otherwise noted.

[3] Tolerance approximately ±10 per cent.

[4] Estimated.

Creole Petroleum Plans Gas Injection Plant

Creole Petroleum Company is planning a 130,000,000 cu ft per day 50,000 hp gas injection plant for pressure maintenance in one of the large BCF reservoirs. It will be built on piles in about 60 ft of water. The whole compressor installation will be gas turbine driven and the compressors are all centrifugal, taking suction at 5 psig and discharging at rated capacity of 1935 psig. Low pressure pick up lines will be up to 30-in.



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• Switching from a blanking union to regular union is a simple, easy job with the WECO FIG. 208 Union. There are only two parts to remove . . . the wing nut and plug. Reversing the connection is just as easy and simple.

The Fig. 208 has less weight . . . less bulk . . . is easier to handle. All parts are interchangeable. The plug and male sub have an "O" ring to protect the metal to metal seal against corrosion and abrasion.

The WECO Fig. 208 has threaded ends . . . the Fig. 209 has ends bored for welding. Available in 3", 4", 6", 8" and 10" sizes. Ask your WECO Representative for details about the wide range of applications of the Fig. 208 Union.

WECO FIG. 208 BLANKING UNION

• Note the simplicity of the Fig. 208 Union and the ease with which it can be made up as a regular or blanking union.

Chiksan Ball Bearing Swivel Joints, (encircled) add greatly to the efficiency of this terminal installation.

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Dinner honoring 275 officers and employees of Shell Oil of Canada Montreal Forces: In center, behind mike, George Davidson, manager, Montreal East refinery; at his right, W. M. V. Ash, Company president; at left of Dinner Chairman Davidson, V. Dessoy, Montreal Division manager.

(Photo: Dwight E. Dolan, Montreal)

Shell Montreal Employees Honored at Award Dinner

W. M. V. Ash, president of Shell Oil Company of Canada, Ltd., told an assemblage of 275 officers and employees of the Montreal contingent, at a dinner in their honor at the Mount Royal Hotel in that city, recently that almost 33 per cent of the Shell personnel in Canada have completed 10 years or more of service and that the aforementioned number present from Montreal were regarded as totaling 4000 working hours.

The occasion was distinguished by the presentation of gold emblems: unadorned, marking 10 years' continuous service; emerald-set, 15 years'; ruby, 20; single diamond, 25; twin diamonds, 30.

George Davidson, manager of the Montreal East refinery, officiated as dinner chairman. His service, coupled with that of V. Dessoy, Montreal division manager, E. V. Vincent, of Montreal division, and W. J. Triggs, of Quebec district, has totaled more than a century. Vincent counts the longest service, with 30 years to his credit.

Ash commented upon the expansion of the company's forces, plants, and operations in the Montreal area since most of those attending had become associated with Shell. Many millions have been invested in refinery expansion within the last few years (the latest described in the September '51 issue of *The Petroleum Engineer* Refining and Gas Processing edition), and a new Shell chemical plant on the Montreal refinery site, due to begin operations by the end of the current year. This is integrated with a mammoth sulfur-recovery-from-natural-gas operation in Alberta, now under way (and to be described and illustrated shortly in this magazine).

Heating Seminar Planned

Date for the 3rd annual John Zink Process Heating Seminar has been set for October 4, at the John Zink Company plant in Tulsa, Oklahoma.

This year's Seminar, which will follow the pattern as set in the two preceding years, will present a program of papers of current interest to the process industries. Authorities of national standing will prepare and read the papers. The usual buffet style banquet, at which the entire group will be guests of John Zink, will follow the formal portion of the Seminar.

Lone Star Plans New Plant

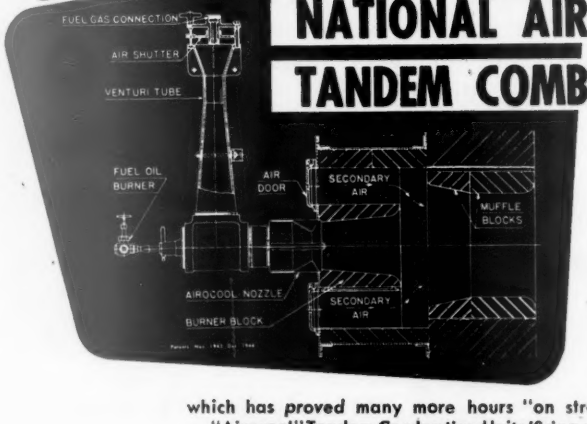
A $3,000,000 natural gasoline plant to process 30,000,000 cu ft of gas from the 250 wells in the Fort Chadbourne field, in northern Runnels and Coke counties, has been announced by President D. A. Hulcy of Lone Star Producing Company, of Dallas. Residue gas will be returned to formations for repressuring. The wells in this field were shut down February first by order of the Texas Railroad Commission, to prevent flaring and thus wastage of gas. Eleven companies operate the wells in this field. The new venture will require 22 miles of pipe varying from two to 16 in. diam, taking gas only from the first-stage separators of the field. Later a second gathering system will be installed to take the gas from the secondary separators. The plant will produce natural gasoline, propane, and butane (LPG).

Kercher Wins Award

An award of $2863, largest yet made to an employee under Socony-Vacuum Oil Company's Suggestion System, has been won by Peter G. Kercher, a foreman in the welding department of the company's refinery at Casper, Wyoming.

He suggested a method for preventing the loss of the bead catalyst used in the refining of petroleum products. Previous ideas that had been tried had proved unsuccessful.

The *Exclusive*



NATIONAL AIROIL OIL-GAS TANDEM COMBUSTION UNIT

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. . . because NATIONAL AIROIL "Airocool" Tandem Units are *more* than just combustion equipment. They are an *exclusive* Combustion System which has *proved* many more hours "on stream" without shutdown.

"Airocool" Tandem Combustion Units (firing dirty refinery gas; uncut asphalt; refinery fuel oils) hold hot air in the combustion zone until fuel and hot air are mixed thoroughly. This means that combustion takes place in a hot zone; the result . . . increased combustion efficiency with a minimum of excess air.

NATIONAL AIROIL Tandem Units add up to 16% further flame travel *without extending the furnace front* . . . eliminating flame impingement on bridge wall and tubes, allowing longer life for those elements . . . and because of this added flame length secondary air is controlled easily and accurately.

The Tandem Unit is popularly fired with NATIONAL AIROIL Combination Oil and Gas Burners. YOU will realize higher profits from YOUR heaters when Tandem Combustion Units are specified. Detailed literature sent upon request on your business letterhead.

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NATIONAL AIROIL BURNER CO., INC.

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Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

Union Oil Sets Up New Chemical Division

Union Oil Company of California has announced establishment of a by-products chemical division to "process raw materials and by-products into marketable chemicals, and provide separate administration and development of such activities."

The company is already manufacturing methyl and ethyl mercaptan at its Wilmington, Delaware, refinery where two additional facilities are under construction as part of Union's expansion into the chemical field.

One plant, scheduled to be completed late this year, will make molten sulfur through the recovery of hydrogen sulfide from refinery gases. The second unit will make ammonium sulfate by processing acid sludge and ammonia, both by-products of gasoline refining.

Sunray Begins Corpus Plant

Preliminary excavation work, the construction of the concrete base for a workman's headquarters, and erection of protective fencing was begun on the site of Sunray Oil Corporation's new Corpus Christi refinery.

Foundation construction equipment is already on the job and construction equipment and materials for preliminary phases of operations are being moved in by The Lummus Company, contractors for the project. Bert Hughes is temporary field superintendent for the Lummus organization and has established an office at the plant site. The plant is to be a 28,000 bbl per stream day catalytic cracking unit with auxiliary processing features. It will be operated in conjunction with the crude oil gathering facilities of Sunray Coastal Pipe Line Company and Sunray's deep water barge and tanker docks at the Port of Corpus Christi.

Texas Refining Climbs

Capacity of Texas petroleum refineries jumped well over half a million barrels per day during the decade from 1941 to 1951, according to figures compiled by the Texas Mid-Continent Oil and Gas Association. Despite tremendous demands on the industry during World War II, the major expansion came in the post-war period of 1946-1951.

Gasoline Plant Underway

Cities Service Oil Company (Delaware) will build a natural gasoline plant near Blackwell, Oklahoma, capable of producing approximately 200,000 gal of total liquids daily. The plant site will be situated on a 160-acre tract approximately two miles northwest of Blackwell.

The plant will produce iso-butane, a vital component of aviation gasoline, natural gasoline, and LP-Gas products. The project includes a pipe line for the movement of products to the recently-modernized Cities Service refinery at Ponca City.

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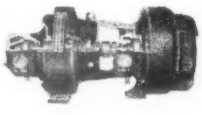
Since 1897 Pyle-National has manufactured their turbines entirely within their own plant . . . thus assuring positive control of quality and workmanship through all stages of production . . . from raw material to the final testing.



The Pyle-National Company also produces a complete line of turbo-generators ranging from 500 to 15000 watts DC for lighting, standby, or other electrical requirements.

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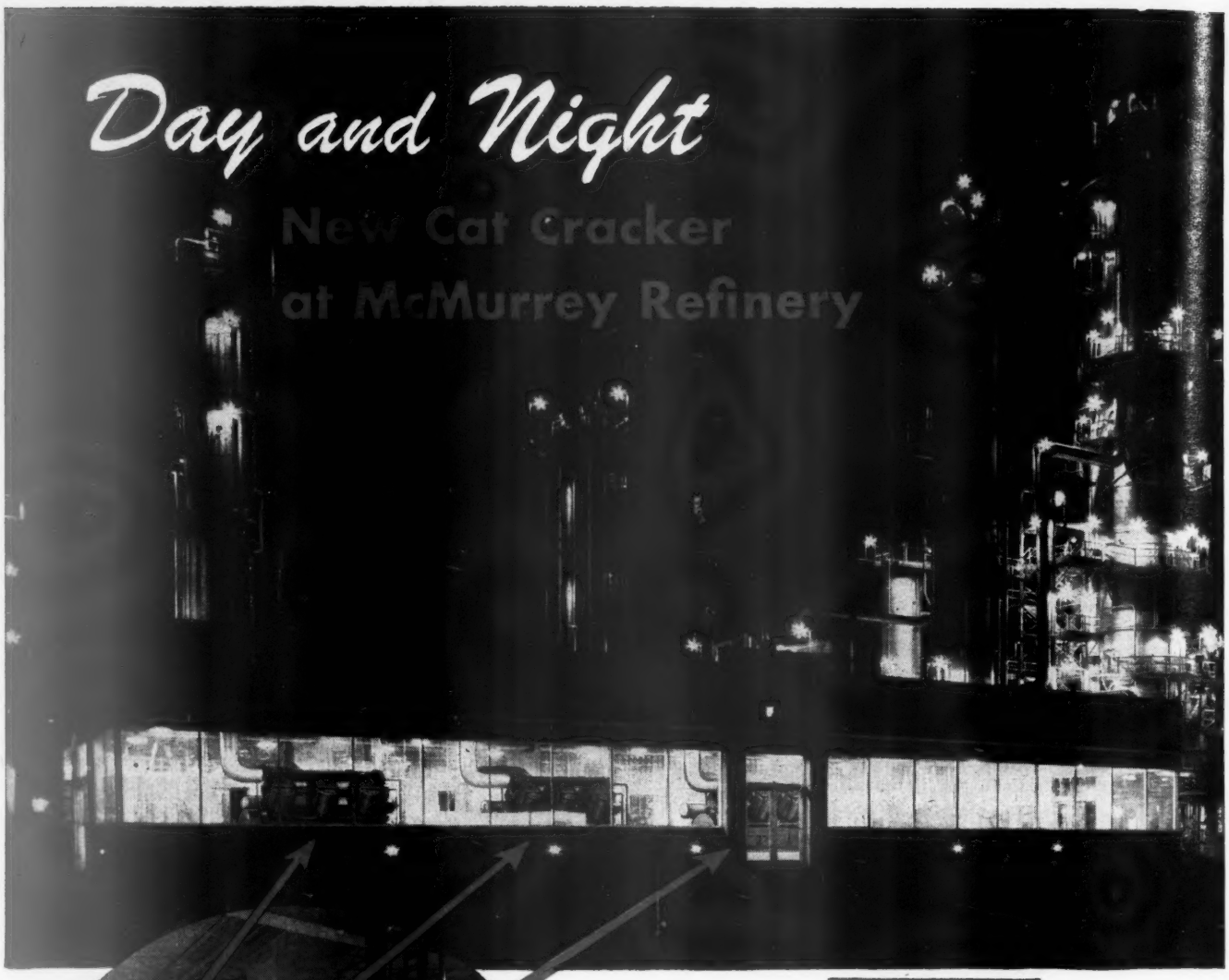
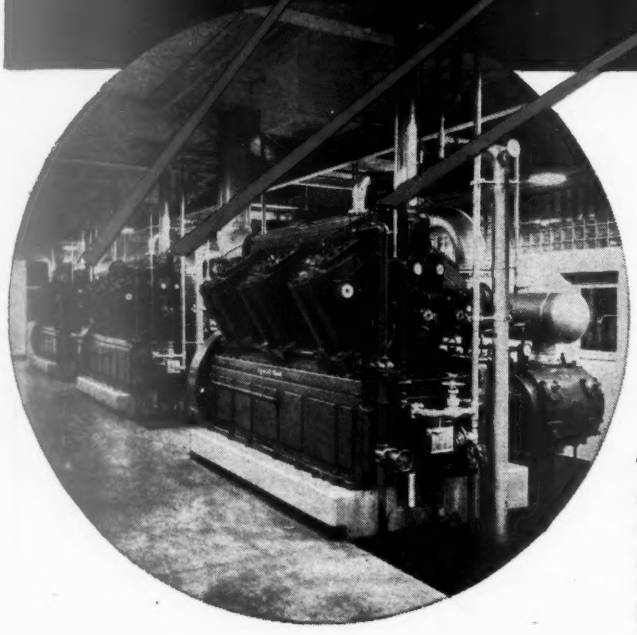




Uses SVG

Gas-Engine-Driven COMPRESSORS for Gas Concentration

The new U.O.P. fluid catalytic cracking unit recently installed at the McMurrey Refinery, Tyler, Texas, gives this progressive oil company an added capacity of 4000 barrels of charge stock per day. To assure uninterrupted service, night and day, year after year, every item of associated equipment has to meet the highest standards of dependability, performance and economy.

The gas-concentration compressors selected for this important job are three Ingersoll-Rand Type SVG gas-engine-driven units. The SVG, also built in 440-hp size, is the new machine that is essentially a modernized version of the famous XVG. Let us tell you more about the SVG, and other sizes in the I-R 4-cycle line . . . gas engine compressors from 110 hp to 1320 hp . . . gas engines to 1760 hp.

Ingersoll-Rand
11 BROADWAY, NEW YORK 4, N. Y.

4-CYCLE

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

Flammability Limits of 155 Gases and Vapors

One of the most comprehensive listings of the limits of flammability of gases and vapors in air or oxygen yet made available in a single volume is contained in a Bureau of Mines bulletin just issued, Secretary Oscar L. Chapman has announced.

Flammability limits, the bulletin explains, are the upper and lower percentages of a gas or vapor which will form an explosive mixture with air or oxygen. For instance, under ordinary circumstances a mixture of methane, the gas commonly found in coal mines, with air is flammable if it contains between approximately 5 and 14 per cent methane. If the air-methane mixture contains less than 5 or more than 14 per cent methane, it loses its flammability, although a mixture at the upper limit may become flammable on contact with outside air owing to dilution of the methane content.

The bulletin is the fourth publication on the subject to be prepared by Dr. H. F. Coward, late Director of Safety in Mines Research, Ministry of Fuel and Power, Great Britain, and G. W. Jones, chief of Gaseous Explosions Branch, U. S. B. of M.

Bureau of Mines Bulletin 503, "Limits of Flammability of Gases and Vapors," can be obtained ONLY from the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., for 40 cents a copy.

Phillips Opens Sulfur Extraction Plant

Phillips Chemical Company has begun operation of its sulfur extraction plant in West Texas. This plant, in the Permian Basin oil fields near Goldsmith, Texas, is designed to extract from natural gas nearly a quarter of a million pounds of elemental sulfur per day. Sulfur from this plant will be trucked in its molten state to a plant in Fort Worth, Texas, where it will be converted into sulfuric acid for subsequent manufacture into ammonium sulfate at the company's plant near Houston, Texas.

Phillips Chemical Company has under construction in Crane County in West Texas a second sulfur extraction plant designed to produce over 100,000 lb of elemental sulfur per day.

PLANT AID

Side boom on winch truck can aid in loading pipe and in laying welded underground lines.

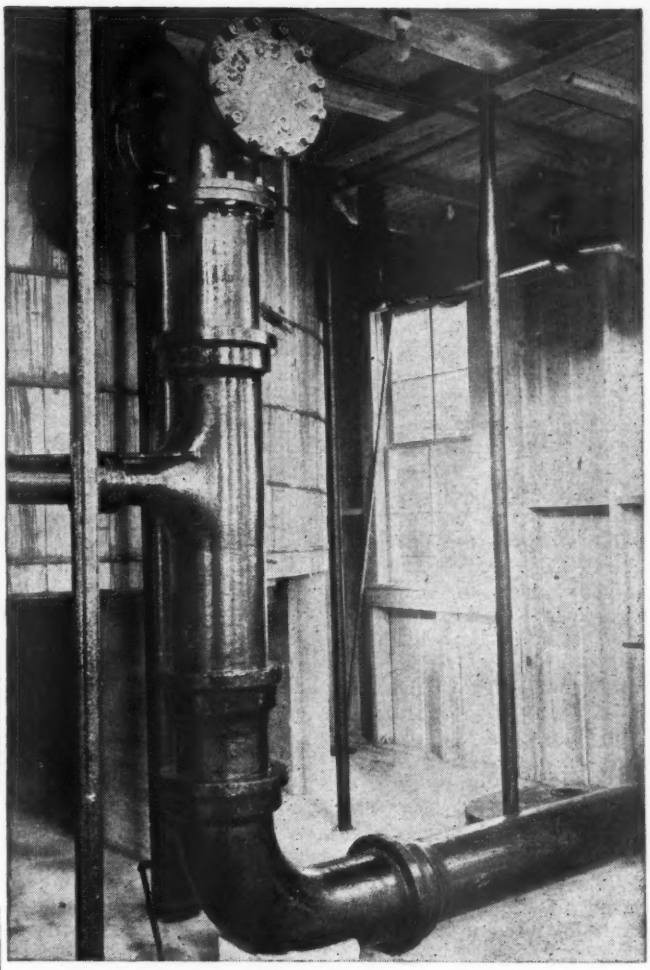
Side Boom Used for Loading Pipe†

H. B. Brown*

We have had excellent service from a side boom constructed to be used on a bob-tailed winch truck. The boom is used for loading pipe and laying welded underground lines. The boom is constructed of 4-in. pipe. It is fastened to the truck bed by means of a pin, so that it may be removed when not in service. The braces are of 3-in. pipe. The truck winch is rigged to the side boom so that it may be used to handle the pipe.

The boom has been especially useful for handling pipe in the ditch while the welder is putting it together. We also tar and prime the pipe while the welder is working on it and while the pipe is held up by the boom.

†NGAA third prize, Class D.
*Construction foreman, Arkansas Fuel Oil Company, Greggton, Texas.



DIRECT ROUTE TO LOWER PLANT MAINTENANCE

The direct and indirect expense of replacements of short-lived refinery pipe lines can be reduced, or avoided altogether, by the use of cast iron pipe. This has been proved by many refineries whose maintenance costs have been lowered by replacing other pipe materials with cast iron.

A relatively low first-cost material, cast iron pipe is usually cheapest in the end, for many refinery applications, because of its stubborn resistance to corrosion. Available with bell-and-spigot, plain end and flanged, or with standardized mechanical joints.

Cast Iron Pipe Research Association, Thomas F. Wolfe, Engineer, 1015 Peoples Gas Bldg., Chicago 3, Illinois.

CAST IRON PIPE
FOR LONG LIFE AND ECONOMY

—PERSONALS—

Dr. Charles L. Smith has been promoted by Ethyl Corporation to the newly-created post of associate director of product development in charge of agricultural chemicals. He will assist William T. Hack, director of product development. Dr. Smith, who has been associated with Ethyl since 1949, has been active in the Corporation's technical work in the agricultural chemicals field. Prior to joining Ethyl, he was technical advisor to the National Agricultural Chemicals Association.

James K. Stanley has been promoted from senior projects metallurgist Standard Oil Company (Indiana) to section head in the materials division of the engineering research department. In his new position Dr. Stanley has general supervision of the research program of the materials division under the general direction of Dr. Carl H. Samans, associate director of the division.

Dr. Stanley joined Standard in 1950 after 13 years' service with Westinghouse Electric Research laboratories as research metallurgist. He is a graduate of Case Institute of Technology and received the Ph. D. degree from the University of Pittsburgh in 1948.

Delmar H. Larson, formerly with Baroid Sales Division, National Lead Company, has opened offices in Los Angeles as a consulting chemical and petroleum engineer and patent agent. He was with Baroid for 15 years, until that firm moved to Texas, and was director of research and more recently manager of the patent department.

Norman C. Penfold, supervisor of automotive and engine, fuels and lubricants research, has been named an associate director of Southwest Research Institute by Dr. Harold Vagtborg, president. One of the "veteran" members of the staff of the four-year-old industrial research organization, Penfold is a recognized authority on internal combustion engines, fuels, and lubricants, and the use of research tools in the evaluation of fuels and lubricants. He will retain full supervision of the Institute's automotive research laboratories, which constitute one of two such independent evaluation and development facilities in the nation.

William Keeler, vice president and assistant to the president of Phillips Petroleum Company, has been named director of the refining division of Petroleum Administration for Defense. He attended the University of Kansas, leaving there in 1933 to work for Phillips in several technical positions. He was named general vice president and assistant to the president of Phillips last year. Keeler is serving without compensation.

W. Vaughn Ischie, of Hammond, Indiana, who has been deputy director of the foreign refining division of the Petroleum Administration for Defense since early in February, has been appointed director of the division. Ballou, who joined PAD's staff in February, 1951, will return to the Calmara Oil Company, New York City.

Ischie has been employed by Sinclair Refining Company since 1920. After working in the research and development department for a number of years, he was named to supervise cracking operations in the company's refineries in 1929. Later he became assistant general superintendent of Sinclair's refinery at East Chicago, Indiana. In 1942 he was appointed operating superintendent of that refinery.

At the time he joined PAD, Ballou was executive assistant to the chairman of Calmara, a subsidiary of the Standard Oil Company of California. From 1946 until he became affiliated with Calmara in 1949 he was associated with the foreign operations organization of the parent company in San Francisco. After working for Union Oil of California for three years, he joined the staff of the foreign refining division of the Petroleum Administration for War in November 1941.

Charles L. Marner, formerly vice president in charge of sales for Graver Tank & Manufacturing Company, Inc., East Chicago, Indiana, is going into consulting work, having severed his connections with the Graver company. His work in the future will deal largely with fabrication of petroleum storage facilities and he is recognized as an authority in problems dealing with design, etc., of vapor-saving equipment and the conservation of light products in storage. Marner is well known in the industry, having been associated with storage and vapor conservation fields since the early days of petroleum production and refining.

Dr. Sidney Katz, supervisor of physical chemistry for the Institute of Gas Technology, has been appointed research physical chemist at Armour Research Foundation of Illinois Institute of Technology.

Known for his research on the kinetics of reactions, carbon-oxygen-steam reaction, and instrumentation methods of analysis, Dr. Katz will work on projects in the physical chemistry and fine particles sections at the Foundation. Dr. Katz has been in research and teaching at the Gas Institute since 1945. He received his bachelor's and master's degrees from the University of Manitoba, Winnipeg, Canada, and his doctorate from McGill University, Montreal. He also spent a year at London University.

Martin E. Gilwood

Martin E. Gilwood has been named director of research, The Permutit Company, New York, New York. A graduate chemical engineer from Rensselaer Polytechnic Institute, Gilwood has risen in successive steps from the positions of research engineer to assistant manager of research to manager of chemical research and finally to director of research.

He will be responsible for all operations of Permutit's research, analytical, and pilot plant laboratories at Birmingham, New Jersey.

Mangum Webb has been named vice president of Chemical Construction Corporation. He joined the firm in 1941 when it was founded, served as Far Eastern representative in Shanghai, China, from 1935 to 1936, as procurement director during World War II, then became assistant sales manager and director of engineering of the ion exchange department of American Cyanamid Company, the parent firm. Webb has been sales manager of Chemical Construction since 1949. He received his education at North Carolina State College.

G. W. Hewitt has been named assistant director of the gas facilities division of the Petroleum Administration for Defense. Hewitt was formerly special assistant to the director of the division, and his new position is a new one within PAD. He will be charged with the supervision and direction of the day-to-day operations of the division under Louis C. Sonnen, the division's director.

Hewitt became associated with El Paso Natural Gas Company in 1946, where he served as traffic manager and engineer and handled special assignments on technical problems. He remained with El Paso Natural Gas until July 1951, when he was named special assistant to the director of the gas facilities division. He will serve without government compensation.

C. A. Johnson, chairman of the board, Socal Refining, has been re-elected president of the Independent Refiners Association of California. **B. E. Devere,** Pathfinder Petroleum, is vice president; **N. D. Taylor,** Hancock Oil, renamed secretary-treasurer, and **D. B. O'Neill,** re-elected vice president and general manager of the association.

The 2038-ft Cimarron River crossing near Yale, Oklahoma, was laid by the dewatering method.

Cushing-Chicago Line Under Construction

Sinclair's new 675-mile system, with initial capacity of 280,000 bbl a day, will serve middlewestern refineries

FRANK H. LOVE*

Two sideboom tractors holding pipe at a road crossing while a tie-in weld is made.

CONSTRUCTION of Sinclair Pipe Line Company's 675-mile crude oil line between Cushing, Oklahoma, and East Chicago, Indiana, is off to an auspicious start with two contractors' spreads working on the mainline and another on river crossings. The section under contract is the 150 miles of 24-in. from Cushing to Humboldt, Kansas, and in the near future bids will be taken on the 181-mile Humboldt-Salisbury, Missouri, section. Pumping stations also are under construction.

This new pipe line system, which will consist of 24-in. pipe as far as Salisbury, will have an initial capacity of 280,000 bbl a day to that point. Reduced to 22-in. diameter between Salisbury and East Chicago, the capacity on that section will be 210,000 bbl.

*Editor, Oil and Gas Pipelining.

EXCLUSIVE

Boring a railroad crossing near Independence, Kansas.

The system will be operated at a pressure of approximately 900 psi. Operation will be a closed system, with tankage only at injection and delivery points.

Pumping equipment in the eight stations will consist of centrifugal units driven by electric motors. The stations will be semi-automatically operated.

At the Cushing station there will be three 1750-hp, 2300-volt motors driving 2-stage centrifugal pumps at a speed of 1785 rpm, and one 900-hp motor driving a single-stage pump at 1800 rpm. Storage facilities at Cushing will consist of two 150,000-bbl and three 135,000-bbl tanks having floating roofs. The last three are carryovers from an older system that will be tied into the new system.

The second station will be at Cobb, Kansas, and will have pumping units identical with those at Cushing. One new 150,000-bbl floating roof tank will be erected and interconnected with existing tankage.

At Humboldt, Kansas, pumping units will be the same as at the two previous stations, and one new 150,000-bbl tank will be installed.

At the Gunn station there will be no tankage and the pumping units will be the same as for the other three stations mentioned.

At Key station near Salisbury, Missouri, the Sinclair system will be interconnected with that of the Platte Pipe Line Company, the latter extending from Wyoming to Wood River, Illinois. At this point there will be interchange of oil between the two systems as occasion warrants. Pumping units will consist of three 1250-hp and one 600-hp motors driving centrifugal pumps at 1785 rpm. Two 150,000-bbl floating roof tanks will be provided.

The Quincy, Illinois, station will be the same as Key insofar as pumping equipment is concerned, however, there will be no tanks.

The station at Forest, Illinois, will not be constructed immediately. Block valves will be set, however, and other connections provided so that this station can be built and tied into the system when needed.

The Flanagan, Illinois, station will

Dozers cutting a channel through the Cimarron River to divert the stream.

Two backhoes digging trench for the Elk River approach under somewhat trying conditions.

have the same pumping units as Quincy, and, as this is a point where lines take off for delivery points, seven 150,000-bbl floating roof tanks will be erected. Delivery points are at Monee, Illinois, Griffith, Indiana, and the East Chicago, Indiana, area. Oil originating in West Texas, North Texas, and southern Oklahoma fields will enter the new line at Cushing. Oil from northern Oklahoma and southeastern Kansas will be injected at Cobb station. Western Kansas oil will enter the line at Humboldt station.

Where tankage is required, the stations are being situated to take full advantage of gravity to pump suctions, and, where necessary, motor-driven centrifugal booster pumps also will be installed at the tanks to provide sufficient head at station suction.

The system when completed will have numerous distinctive features. One of these will be the use of strain-gage type pressure pickups for electrical transmission of pressures, which will serve to keep products out of the control room and thus reduce the number of hazardous areas. In conjunction, the same system will be used for high and low pressure shut down. This type of equipment lends itself to transmission of pressure and rate of flow intelligence via microwave radio.

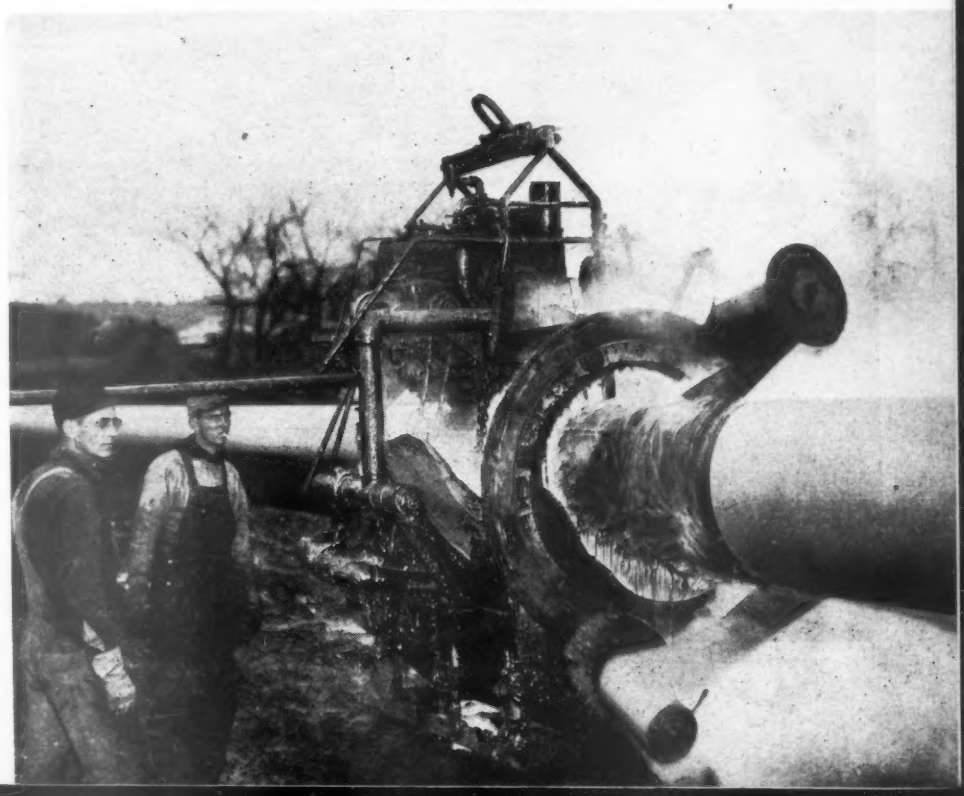
Further, all main valves will be electrically controlled from the control room. All circuits will be underground, there being no pole lines except for incoming high voltage. Transformers, incidentally, will be 3-phase, 6000-kva installations on the 24-in. section of the line and 3-phase, 5000-kva on the 22-in. section. All substations are completely waterproof metal clad unit type substations.

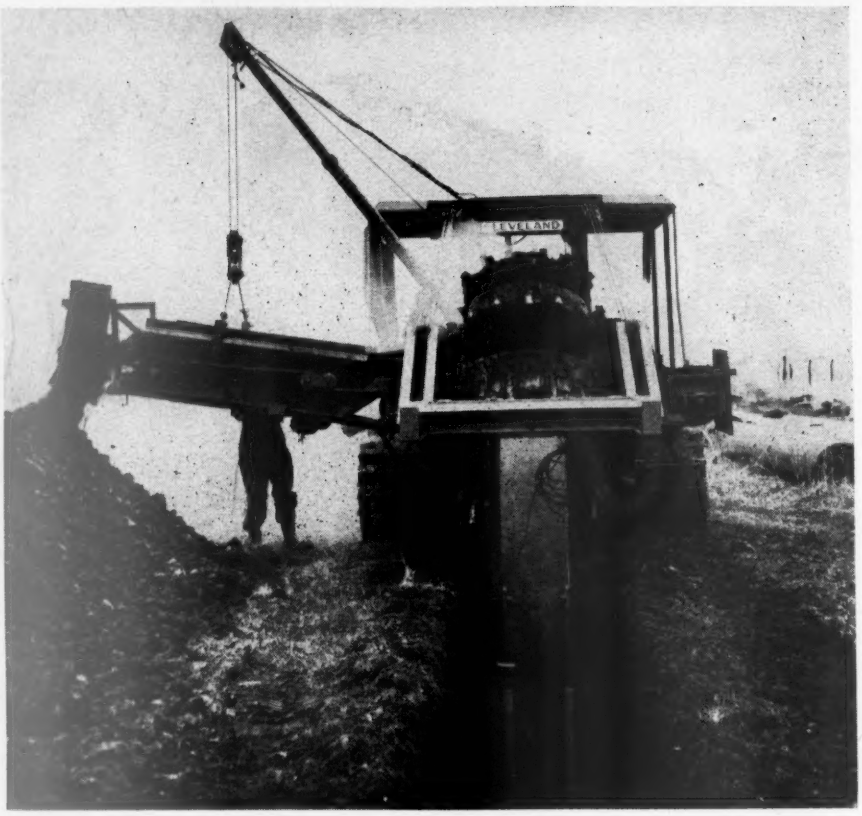
Electronic tank gaging equipment will be provided, with high and low level alarms on the tanks.

The motors will be base ventilated. A special fan room contains a separate fan for each motor. Thermocouples in the motors will serve as a means of protection with respect to stator temperature, stator bearings, and pump case temperature.

The exterior of the station buildings will be constructed of smooth-faced brick. The roof will be of monolithic poured concrete and pre-stressed slab. All walls will be insulated. The interior of the control room will be of structural glazed tile and floors of rubber asphalt. The floor of the pump room will be of

Coating with enamel and wrapping with glass fiber.





Ditching in the vicinity of Independence.

smooth finished concrete. Between the control room and the pump room will be a look window, giving the operator a full view of the latter. The piping side of the pump room will be insulated. The outer side will be a metal wall with a solid line of windows. A craneway in the pump room will extend the full length of the room. The control room will have a suspended acoustical ceiling for better sound control.

The console desk in the control room contains all the start-stop stations for motors, motor-operated valves, and pressure gages.

The fan room contains, in addition to the motor ventilating fans, equipment for heating the control and pump rooms, all heating being done with electric units.

Line pipe is X-52 having a 60,000-psi ultimate tensile strength. Main line pipe has a wall thickness of 9/32 in. The 24-in. pipe weighs 71.25 lb per ft. On the discharge side of stations pipe having a wall thickness of 11/32 in. is used. The distance out of each station that the thicker walled pipe is used varies from 27 to 52 miles, according to the station and the particular problem connected with its location. This pipe weighs 86.85 lb per ft. These weights are for 24-in. pipe.

In the case of river crossings, ½-in. wall pipe is being installed. Tensile strength is the same as for main line pipe but the weight per ft is 125.49 lb for 24-in. and 114.81 lb for 22-in. Additionally, pipe used in river crossings is given still greater weight by the installation of concrete clamps weighing 5373 lb each and spaced on 25-ft centers. The Cimarron River has already been crossed near Yale, Oklahoma, and work is now going forward on the Arkansas River crossing in the same general vicinity. The Cimarron crossing was installed by means of dewatering the river and the same method is being employed on the Arkansas. Other major rivers that will be crossed are the Little Caney, Big Caney, Elk, Neosho, Marais des Cygne, Missouri, Chariton, Mississippi, and Illinois. All are single lines and before the river clamps are installed the pipe is given two coats of hot enamel, a glass fiber wrap, and a paper wrap. A concrete-type coating is being considered for the Missouri, Mississippi, and Illinois rivers. On the rest of the system a single coating of hot enamel, 3/32 in. thick, is being applied, together with glass fiber and paper wrap.

The Burden Construction Corporation, Tulsa, Oklahoma, is the general contractor on the section from Cushing to Humboldt. Western Pipe Coating Company, Inc., Iola, Kansas, subcontracted the coating, and J. L. Cox and Son of Raytown, Missouri, the stringing.

* * *

Checking coating for voids with a holiday detector.

Gas Storage Underground

At the beginning of 1951, the gas industry had about 350 billion cubic feet of natural gas stored underground, an amount equal to one-fourth of the annual residential gas consumption in the United States. In the next three years the industry will spend about one half billion dollars in the development of these underground savings banks. Almost one dollar out of every five spent by gas utilities for plant improvement will go for underground storage for natural gas in the East, Midwest, and on the Pacific Coast.

Protective Casings for Pipe Lines*

Results of research on structural performance of some flexible type underground conduits

M. G. SPANGLER†

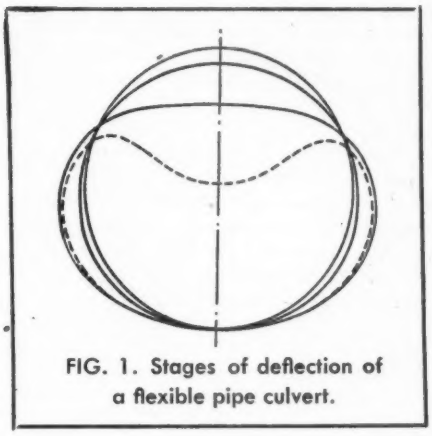


FIG. 1. Stages of deflection of a flexible pipe culvert.

WHEN pipe lines carrying fluid petroleum products, such as crude oil, gasoline, or natural gas pass beneath railroad tracks and right-of-way it is frequently required that the carrier line be encased in a protective pipe of larger diameter. This protective casing pipe is subjected to the loads caused by the earth embankment above it and by the traffic over the rails. Because of the large number of railroad and highway crossings, the structural design of the casing pipe to insure adequate strength, safety, and reasonable economy in the construction of pipe line crossings is a problem of considerable interest and importance to the pipe line industry. The purpose of this paper is to present the results of certain researches that have been carried out at Ames, Iowa, by the Iowa Engineering Experiment Station in cooperation with the U. S. Bureau of Public Roads, and which it is believed have an important bearing on this problem. These results will be incorporated in a suggested procedure for the structural design of protective casings for pipe lines.

In general, buried pipes may be divided into two classes on the basis of the amount of deformation which they can withstand without structural damage. These classes are: 1, rigid pipes, such as those made of concrete and burned clay; and, 2, flexible pipes, such as those made of relatively thin corrugated metal sheets or steel line pipe.

Rigid pipes fail under external loading by rupture of the pipe wall[8] when the outer fiber stresses at points of maximum bending moment exceed the strength of the material of which the pipes are made. These failure stresses occur when the deflection of the pipe ring is relatively small; hence the term "rigid." As an illustration, the deflection, i.e., the shortening of the vertical diameter and the lengthening of the horizontal diameter of a heavy-walled concrete pipe at the time of rupture of the material, is measurable only in hundredths of an inch.

In contrast, the flexible pipes are capable of withstanding relatively very large deflections without rupture of the pipe wall or other evidence of structural damage. When a flexible pipe is installed as an underground conduit, the external loads and pressures to which it is subjected cause the pipe to deflect in a manner somewhat as shown in Fig. 1. The first increments of load cause the initially circular ring to assume an elliptical shape. As the loading increases, this tendency continues until the top of the pipe is essentially flat for a considerable distance. Further increases in load may cause the top of the pipe to reverse its curvature and become concave upward, while the sides of the pipe pull inward as the pipe proceeds toward complete collapse. The whole action is one of large deflection change unaccompanied by rupture or buckling of the metal ring, although the material in certain parts of the ring may be stressed well beyond its elastic limit.

The author has never seen a flexible pipe under a fill load that has deflected to the extent shown in Fig. 1. However, a 60-in. 12-gage corrugated metal pipe culvert under a highway in Linn County near Cedar Rapids, Iowa, has been under observation since it was installed in 1939. The moment of inertia of the corrugated sheet of which the pipe is made is 0.003367 in.[4] per in. This culvert pipe has undergone an exceptionally large amount of deflection, as shown in Fig. 2, because of certain unusual circumstances which have reduced the ability of the soil at the sides of the pipe to resist lateral movement. The actual shape of the pipe conforms reasonably well with the hypothetical shape shown in Fig. 1 as far as it has developed to date. There is no evidence of rupture of the pipe wall, and it is still serving satisfactorily as a highway culvert, although it has deformed far beyond the amount that is considered to be a prudent limiting value for design purposes.

Buried pipes derive their ability to support the vertical loads to which they are subjected from the inherent strength of the pipe and from lateral earth pressures acting against the sides. These lateral pressures produce stresses in the pipe ring that act in the opposite direction to those caused by the vertical loads, thereby augmenting the inherent load-carrying capacity of the pipe. Soil

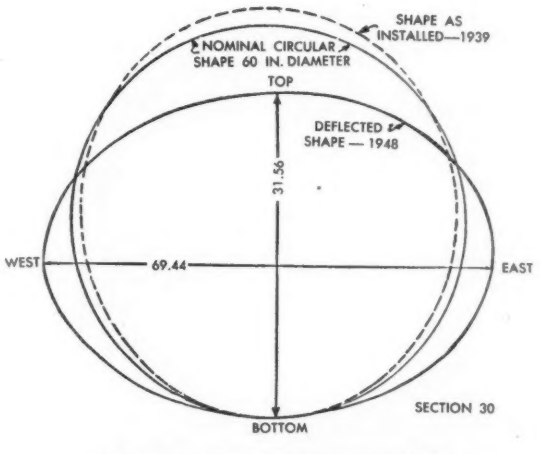


FIG. 2. Linn County highway culvert.

*Presented before American Petroleum Institute, Division of Transportation, November 6, 1951, Chicago, Illinois, under the full title "The Structural Design of Flexible Protective Casings For Pipe Lines."

†Research professor of civil engineering, Iowa Experiment Station, Iowa State College, Ames, Iowa.

is neither a fluid nor a solid, but it possesses some of the properties of each of these states of matter. One characteristic that is similar to that of a fluid is its ability to exert lateral pressure against a structure with which it comes in contact. If the structure against which the soil impinges is essentially stationary, the pressure developed is called "active lateral pressure." On the other hand, if the structure moves toward the soil, the pressure developed is called the "passive resistance pressure" of the soil. It is always very much greater than the active pressure produced by the same soil.

In the case of rigid pipes, the outward movement of the sides of the circular ring under the influence of vertical loads is negligible, and the only lateral pressure that can be relied upon to augment its load-carrying capacity is the active lateral pressure of the soil.

With flexible pipes, however, the situation is very much different. As these flexible rings deform under vertical load in the manner described above, the sides move outward against the soil a sufficient distance to develop a substantial amount of the passive resistance pressure of the soil. These pressures greatly increase the load-carrying capacity of this flexible type of structure and account for the fact that thin light-weight pipes, when properly installed, are capable of supporting the heavy loads produced by relatively high embankments. This ability of a flexible pipe to deform readily and thus utilize the passive resistance pressure of the soil on each side of the pipe is its principal distinguishing structural characteristic. Any attempt to analyze the structural behavior of a buried flexible pipe must take into account the passive resistance pressures developed by the soil at the sides of the pipe, as a major source of supporting strength. Also, inasmuch as flexible pipes fail by excessive deflection rather than rupture of the pipe wall, a method of structural design should be directed toward predetermining the deflection* of the pipe under specified conditions of installation and loading.

The deflection of a loaded circular pipe can be determined by the theory of elasticity applied to thin rings in the following manner.[9]

Let:

r = radius of unloaded ring.
ρ = radius of loaded ring at any point.
M = bending moment at any point on the ring.
E = modulus of elasticity of ring material.
I = moment of inertia of cross-section of the ring.

Then:

$$\frac{1}{\rho} - \frac{1}{r} = \frac{M}{EI} \quad . \quad . \quad . \quad (1)$$

Where:

$\left(\frac{1}{\rho} - \frac{1}{r}\right)$ = the change in curvature between the unloaded and loaded state.

Also:

$$\frac{1}{\rho} - \frac{1}{r} = \frac{d\theta}{ds} \quad . \quad . \quad . \quad (2)$$

Where:

$d\theta$ = angle through which a plane section normal to the curve of the elastic ring rotates as the ring is loaded.
ds = length of arc within which $d\theta$ occurs.

Substituting equation (2) in equation (1):

$$\frac{d\theta}{ds} = \frac{M}{EI} \quad . \quad . \quad . \quad (3)$$

$$\text{Also } ds = \rho d\phi \quad . \quad . \quad . \quad (4)$$

Where:

ϕ = the central angle between the vertical axis and the radius to the point whose deflection is being considered, and $d\phi$ is the increment of ϕ corresponding to ds.

In the elastic theory applied to thin rings, it is assumed that the difference between r and ρ is negligible, and equation (4) may be written:

$$ds = r d\phi \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Therefore, substituting equation (5) in equation (3):

$$\frac{rM}{EI} = \frac{d\theta}{d\phi} \quad . \quad . \quad . \quad (6)$$

In equation (6) the expression $\frac{d\theta}{d\phi}$ represents the rate of change of the angular displacement of normal cross-sections with respect to the central angle with the vertical, ϕ.

When external loads on the ring are symmetrical about the vertical axis, the tangents to the circle at the top and bottom will remain horizontal, and the normal cross-sections at these points remain vertical regardless of the direction and magnitude of the angular displacements of tangents and normal sections at intermediate points. Therefore, the sum of all the elementary angular displacements, $\Sigma d\theta$, as ϕ varies from 0 to π, will be zero; and, when the left side of equation (6) is integrated between these limits, we obtain:

$$\frac{r}{EI}\int_0^{\pi} M d\phi = 0 \quad . \quad . \quad (7)$$

Or simply:

$$\int_0^{\pi} M d\phi = 0 \quad . \quad . \quad (8)$$

The moment and thrust resulting from any system of loads that is symmetrical about the vertical axis may be obtained from equation (8), for either the top or bottom point on a ring, by substituting a general expression for moment of the actual loads for M. From the moment and thrust at either of these points, the moment, tangential thrust, and radial shear may be obtained at any point of the ring by the equations of equilibrium.

The vertical and horizontal deflections of the ring may be derived by the displacement theory of arches.[2, 3, 13] In this theory the origin is taken at a point on the ring that is assumed to be free to move with respect to any other point. The displacement of any intermediate point is the product of the moment at that point multiplied by its ordinate measured perpendicularly to the supposed displacement. Thus if A in Fig. 3 is regarded as the fixed point and C the free point, the ordinate in question in the case of horizontal movement of any intermediate point D is the vertical distance from C to D, or:

$$r(1 - \cos\phi).$$

Therefore, when D is at B midway between A and C, the horizontal displacement of B relative to A is obtained by multiplying the moment at B by $r(1 - \cos\phi)$, which gives:

Horizontal displacement =

$$\frac{r}{EI}\int_0^{\frac{\pi}{2}} Mr(1 - \cos\phi)\, d\phi$$

. . . . . (9)

When the ring is symmetrically loaded about the vertical axis, the horizontal displacement of B relative to A is equal to one-half the horizontal deflection.

Therefore:

$$\Delta X = \frac{2r^2}{EI}\int_0^{\frac{\pi}{2}} M(1 - \cos\phi)\, d\phi$$

. . . . . (10)

Equation (10) applies for any type of loading that is symmetrical about the vertical axis. If the loads are also symmetrical about the horizontal axis, the normal cross-sections at the ends of the horizontal diameter $\left(\phi = \frac{\pi}{2}\right)$ will not rotate in relation to their unloaded positions, and the tangents at the sides of the ring will remain vertical. Under these conditions equation (10) may be simplified by substitution of the relationship:

$$\int_0^{\frac{\pi}{2}} M d\phi = 0$$

Which gives:

$$\Delta X = \frac{2r^2}{EI}\int_0^{\frac{\pi}{2}} M \cos\phi d\phi$$

. . . . . (11)

Similarly, the vertical displacement of C relative to A, i.e., the vertical deflection of the ring, may be shown to be:

$$\Delta Y = \frac{r^2}{EI}\int_0^{\pi} M \sin\phi d\phi$$

. . . . . (12)

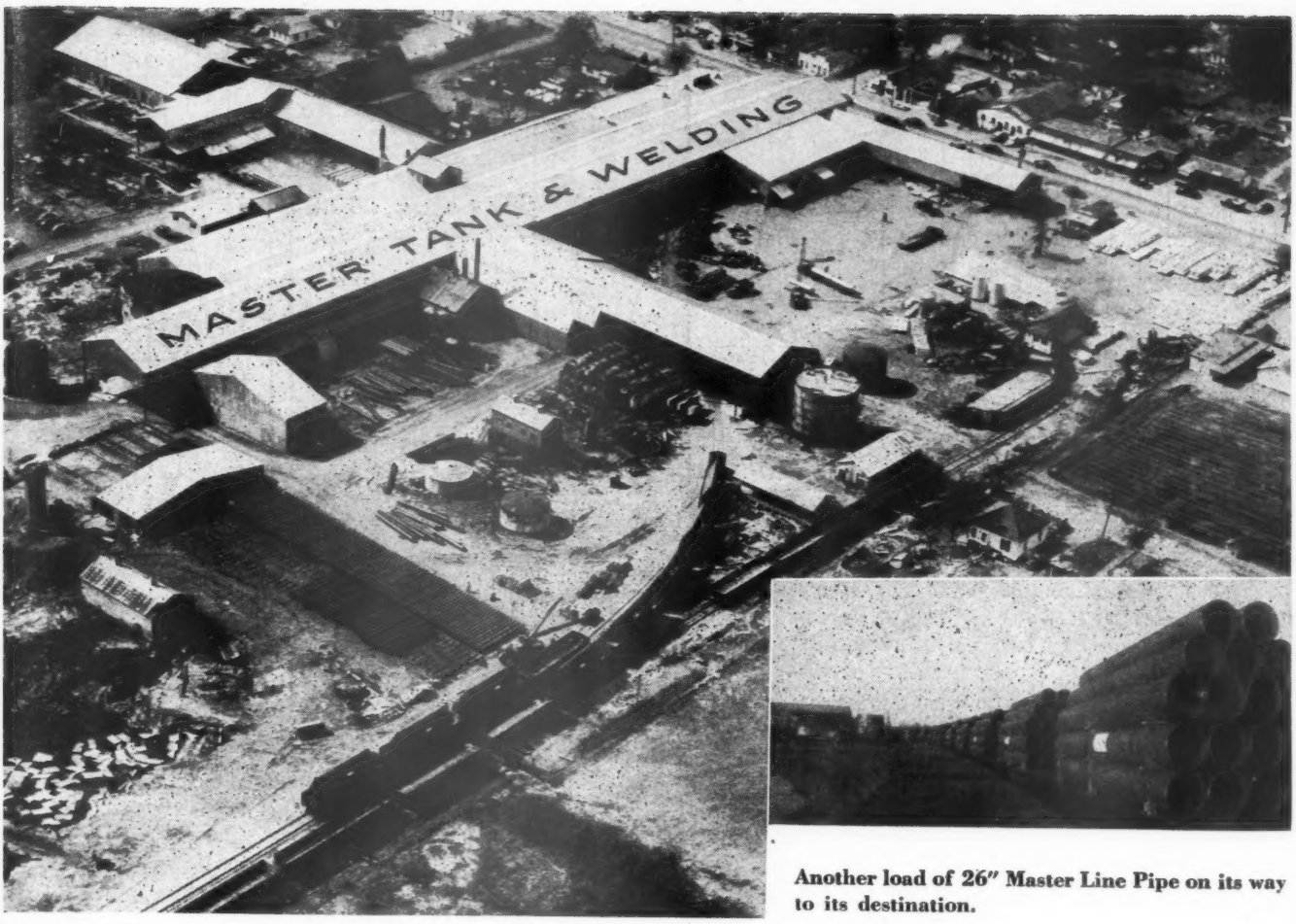
For a load and reaction applied at vertically opposite points of a ring, the expression for moment at the top and at the bottom is:

$$M_A = M_c = 0.318\ Pr \quad . \quad . \quad . \quad (13)$$

And for the moment at the sides:

$$M_B = -0.182\ Pr \quad . \quad . \quad . \quad . \quad (14)$$

* This conclusion is at variance with the opinion held by the author in 1932, when a method of designing casing pipes was suggested that was based upon a limiting value of outer fiber stress in the pipe wall [see *Engineering News-Record* 108, 580-81 (1932)]. Subsequent researches have convinced the author that the fiber-stress method gives results that are ultra-conservative and uneconomical.



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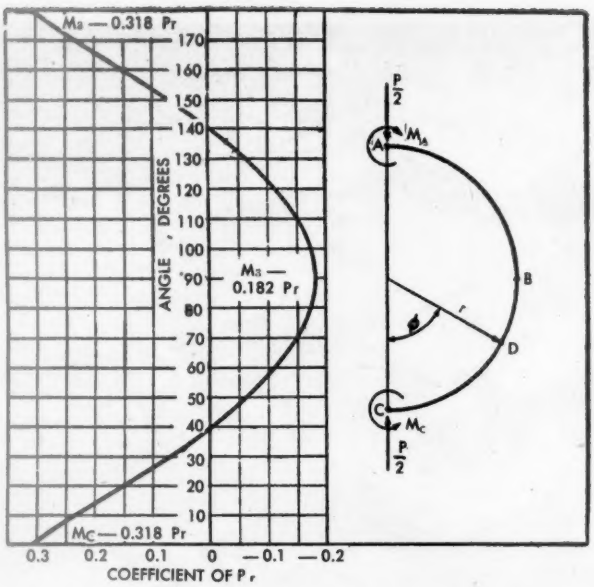

FIG. 3. Moment diagram for a thin elastic ring loaded at top and bottom.

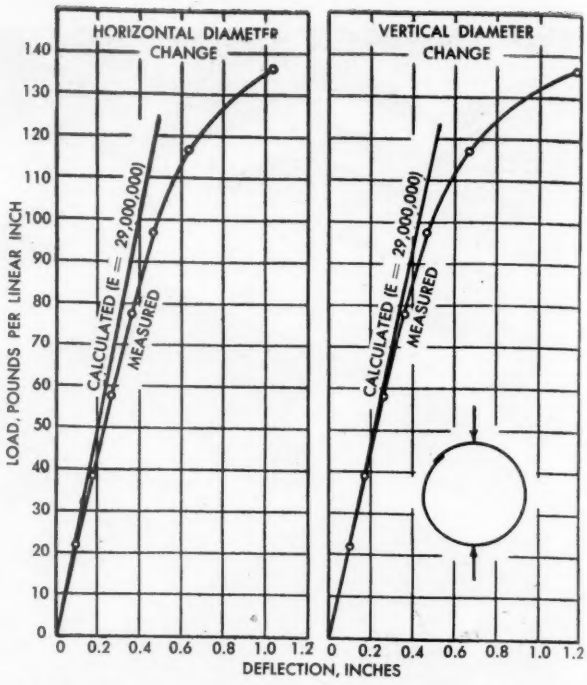

FIG. 4. Deflection of a 24-in. 14-gage corrugated metal pipe under a 2-edge load.

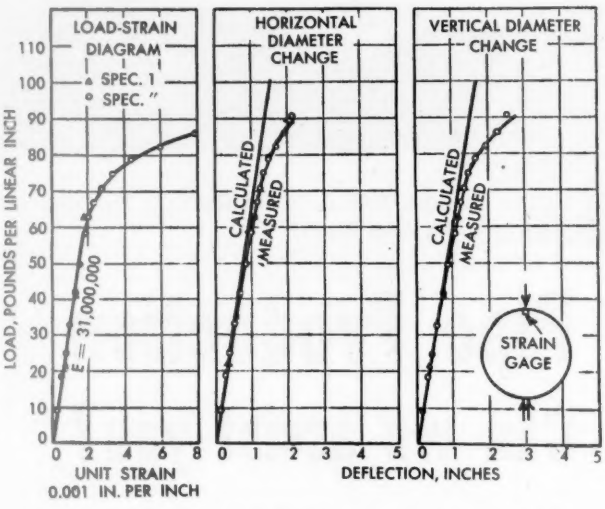

FIG. 5. Deflection and strain of 2 specimens of 36-in. 16-gage corrugated metal pipe under a 3-edge load.

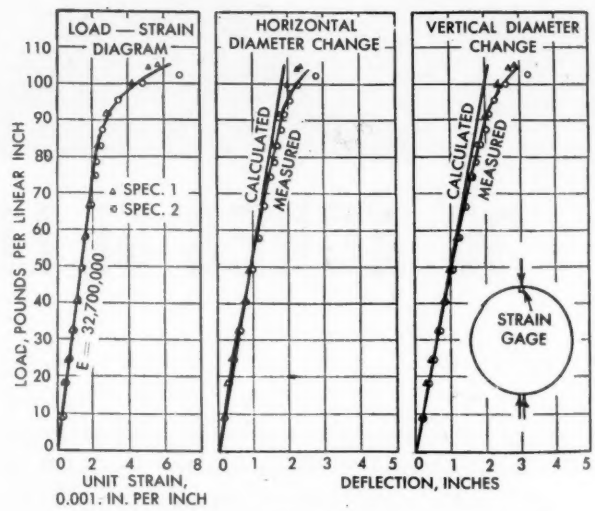

FIG. 6. Deflection and strain of 2 specimens of 42-in. 14-gage corrugated metal pipe under a 3-edge load.

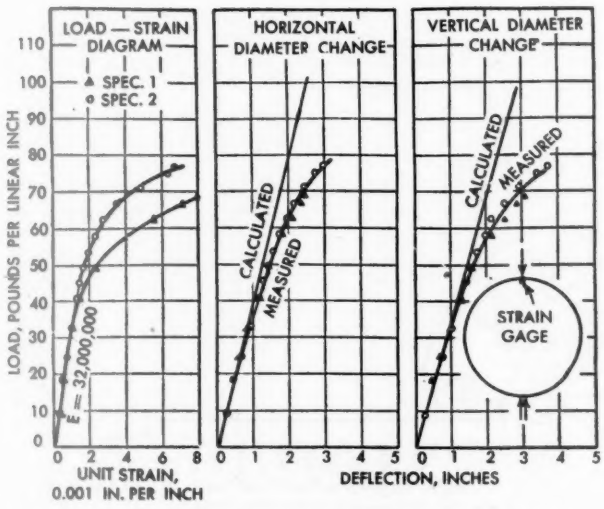

FIG. 7. Deflection and strain of 2 specimens of 48-in. 14-gage corrugated metal pipe under a 3-edge load.

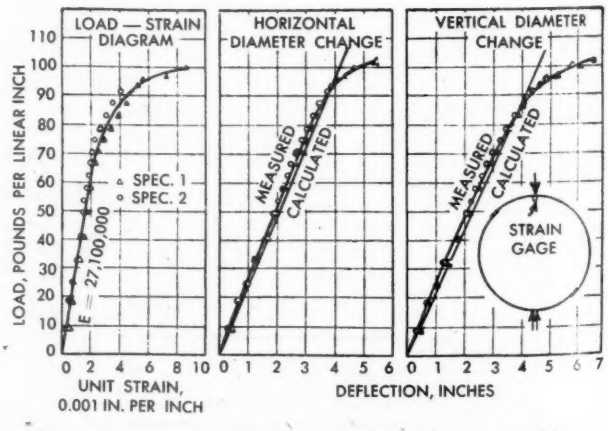

FIG. 8. Deflection and strain of 2 specimens of 60-in. 12-gage corrugated metal pipe under a 3-edge load.

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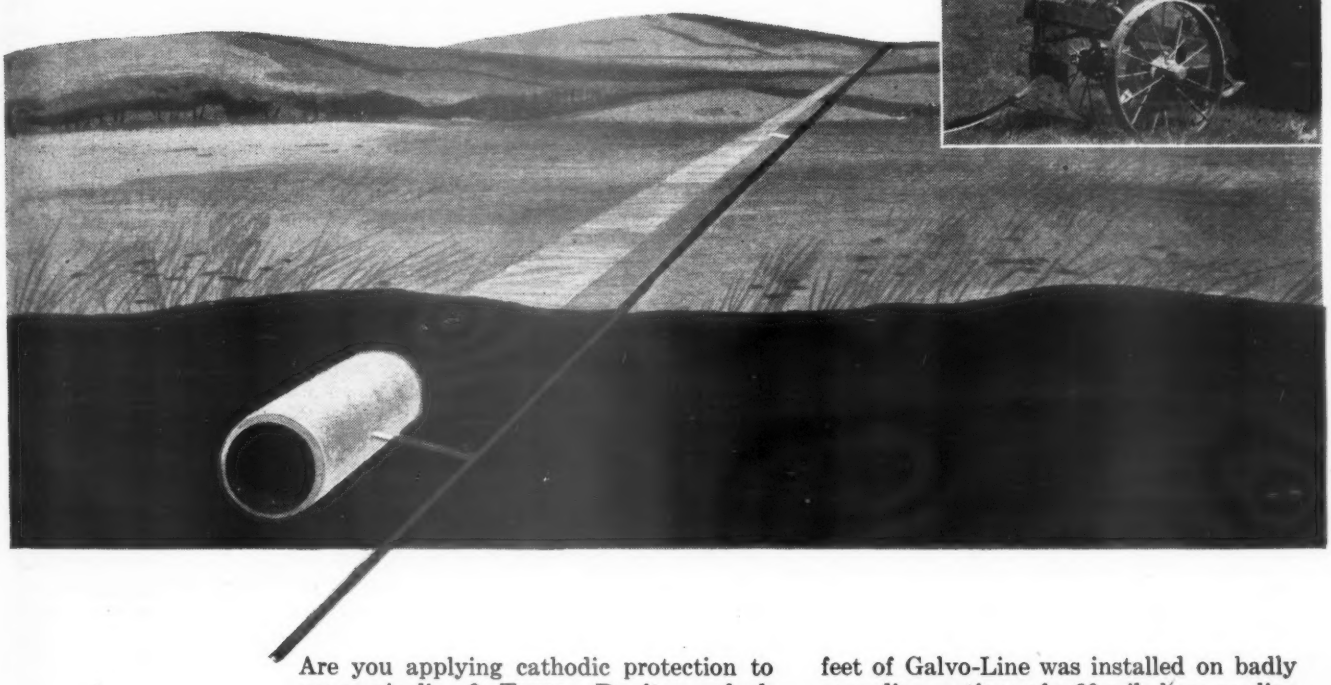

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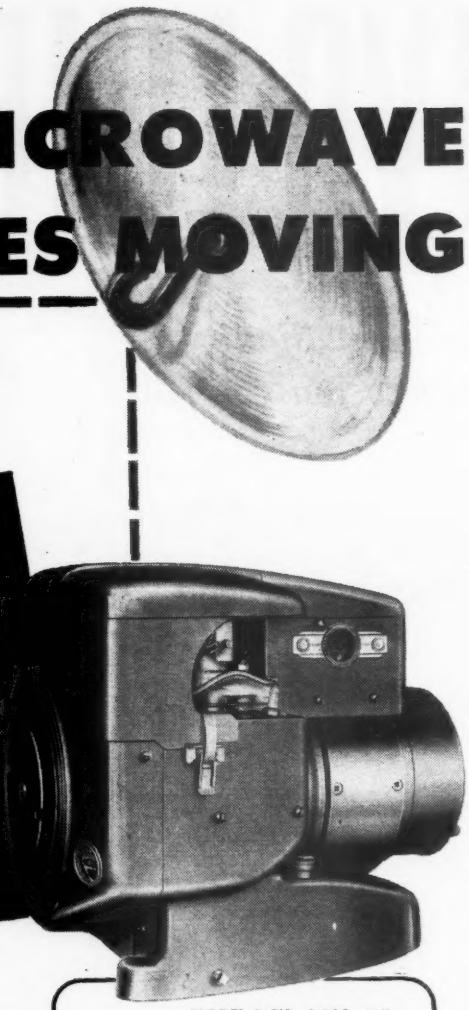

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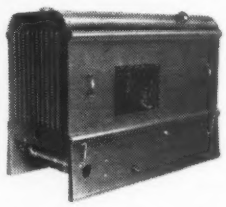

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Where:

P = the load on the ring.

For this same loading situation, the expressions for vertical and horizontal deflections of the ring are, respectively:

$$\Delta Y = 0.149 \frac{Pr^3}{EI} \quad . \quad . \quad (16)$$

$$\Delta X = 0.136 \frac{Pr^3}{EI} \quad . \quad . \quad (17)$$

In order to verify the applicability of the elastic theory of thin rings for determining the deflection of flexible culvert pipes, a number of specimens of corrugated metal culvert pipes were loaded at the top and bottom in the laboratory[9] and the measured deflections of the pipes were compared with deflections calculated by equations (16) and (17). These specimens were 2 ft long, and ranged in diameter from 24 in. to 60 in. The thicknesses of the metal sheets of which the pipes were formed were 14-gage and 12-gage, and the corrugations were ½ in. deep and at 2⅔-in. spacing. The moments of inertia of the pipe walls were 0.002326 and 0.003317 in.[4] per in., respectively. Comparisons between the measured and calculated vertical and horizontal deflections are shown in Fig. 4 through Fig. 8. They indicate that the elastic theory is applicable for determining the deflections of flexible pipes within the elastic range of the metal.

When a flexible pipe is buried in the ground, the loading situation is, of course, very much different from that employed in the aforementioned laboratory tests. The Iowa Engineering Experiment Station has conducted research in the general field of structural analysis and supporting strength of underground conduits of many types during the last 40 years, and some general conclusions have been reached relative to the behavior of such structures and the soil around them. One of these conclusions is that the soil over a conduit produces vertical load on the structure in accordance with Marston's conduit-load theory,[5] and that this load is approximately uniformly distributed over the top of the structure. Another is that traffic loads applied at the ground surface are transmitted down to the structure approximately in accordance with the Boussinesq theory of stress distribution in an elastic medium.[7]

In the case of a circular pipe, the vertical reaction on the bottom is distributed over some width that is narrower than the width of the pipe. This distribution depends upon the width of contact between the pipe and the soil below and the rigidity or flexibility of the pipe. With rigid pipes the reaction, which is a passive pressure, will tend to be greater near the center of the pipe owing to the circular shape. With flexible pipes this tendency is counteracted by the relatively large deflection of the pipe, which causes the bottom segment to flatten out, increases the intensity of the reaction near the edges of the bedding, and brings about a more nearly uniform distribution of pressure over the width of the bedding.

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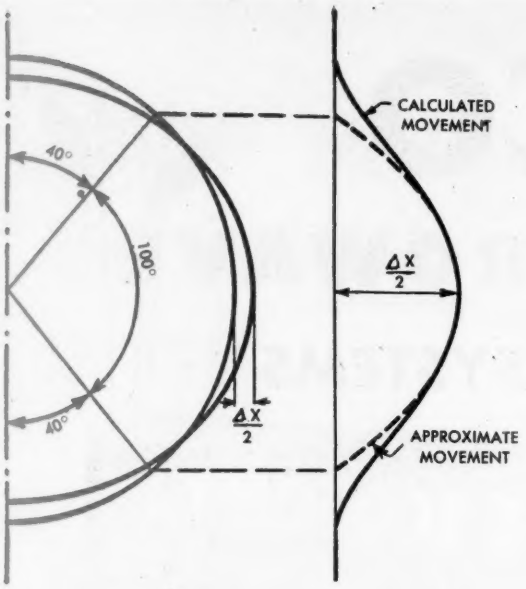

FIG. 9. The horizontal movement of the sides of a circular ring when it is deformed into an ellipse.

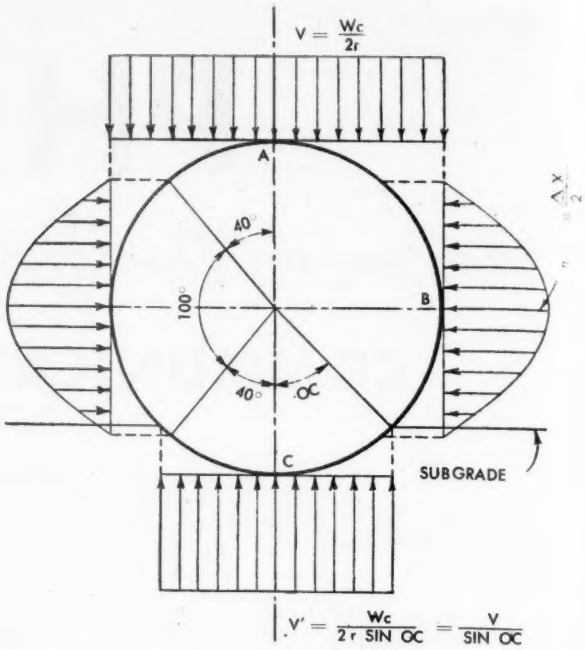

FIG. 10. The distribution of pressures around a flexible pipe under an earth fill.

There is very little information in the engineering literature relative to the magnitude of the passive resistance pressures that are developed at the sides of a flexible pipe as it deflects and moves outward against the enveloping earth. In the Rankine theory of lateral earth pressures, the limiting value of the ratio of passive horizontal pressure to vertical pressure that a granular soil without cohesion can develop is shown to be the reciprocal of the active pressure ratio; i.e., when the active lateral pressure is about one-third the vertical pressure, the limit of passive pressure is three times the vertical pressure or nine times the active lateral pressure. However, the theory does not give a clue as to the amount of movement required to develop this full limit of passive pressure or the relationship between pressure and movement for pressures less than the limiting value.

A number of experiments[9] have been conducted by the Iowa Engineering Experiment Station at Ames, Iowa, in which flexible pipes have been loaded under earth fills. In these experiments the deflections of the pipes and the lateral pressures on the sides of the pipes at the ends of the horizontal diameters were measured. These specimens were corrugated metal culvert pipes ranging in diameter from 36 in. to 60 in. The results of similar observations on five flexible pipes, which were made at the University of North Carolina, are also available in the literature.[1, 2] The North Carolina specimens consisted of both corrugated pipes and smooth iron pipes, and were 20 in. and 30 in. in diameter.

A detailed study of the relationship between lateral movement of the pipe side wall and the magnitude of passive resistance pressure on the pipe indicates that the pressure thus developed is a direct function of the amount of movement, and the pressure can be expressed as a constant multiplied by the movement. This constant ratio has been called the "modulus of passive pressure" of the soil material at the sides of the pipe, and may be expressed as units of pressure per unit of movement, such as pounds per square inch per inch.

On the basis of this hypothesis, if the lateral movements of various points on a pipe ring are known, the magnitude and distribution of lateral pressures on the pipe can be determined by simply multiplying the movement of any point by this modulus.

In general, a flexible metal pipe under an embankment load deforms from a circular to an elliptical shape—with the minor (vertical) axis of the ellipse less than the diameter of the circle by the amount of the vertical deflection, and the major (horizontal) axis greater than the original diameter by the amount of the horizontal deflection. If the length of the periphery of the original circle and of the ellipse is assumed to be the same, it is possible to calculate the horizontal movement of any point on the circle as it deforms to the elliptical shape. The locus of the horizontal movement of all points on a half-circle is a witch-shaped curve, as shown in Fig. 9. However, inasmuch as the movement of points within the top and bottom 40-deg segments is small, a simpler parabolic curve embracing only the middle 100 deg of the semi-circle may be substituted for the witch without appreciable error.

Inasmuch as pressures are assumed to be proportional to movement, the passive pressures on each side of the pipe are also distributed parabolically over the middle 100 deg of the pipe; and the maximum unit pressure, which will occur at the ends of the horizontal diameter, is equal to the product of the modulus of passive pressure of the fill material multiplied by one-half the horizontal deflection of the pipe.

In the light of the foregoing discussion, the loads acting on a flexible pipe under an embankment may be assumed to be as follows:

(1) The vertical load may be determined by Marston's theory of loads on conduits, and is distributed approximately uniformly over the width of the pipe. In the case of a flexible casing pipe under a railroad embankment, the load transmitted through the soil from the rail traffic can be calculated by the Boussinesq theory, and it is additive to the earth load.

(2) The vertical reaction on the bottom of the pipe is equal to the vertical load, and is distributed approximately uniformly over the width of bedding of the pipe.

(3) The passive horizontal pressures on the sides of the pipe are distributed parabolically over the middle 100 deg of the pipe, and the maximum unit pressure is equal to the modulus of passive pressure of the side-fill soil multiplied by one-half the horizontal deflection of the pipe.

The distribution of pressures around a flexible pipe under an embankment, determined in accordance with the foregoing load hypothesis, is shown graphically in Fig. 10.

With a load hypothesis established, it is possible, by substituting the actual moment equations in equation (11), to develop a mathematical expression for the horizontal deflection of a flexible pipe in terms of the load, the properties of the pipe, and the properties of the soil at the sides of the pipe. This expression is:

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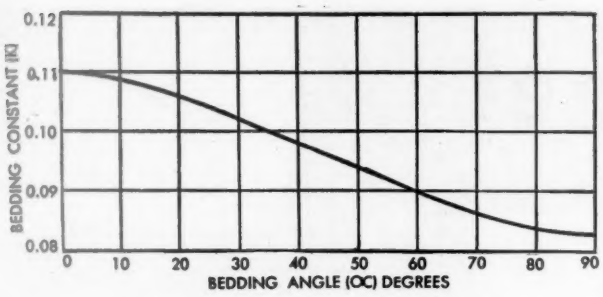


FIG. 11. Bedding constants for various widths of bedding.

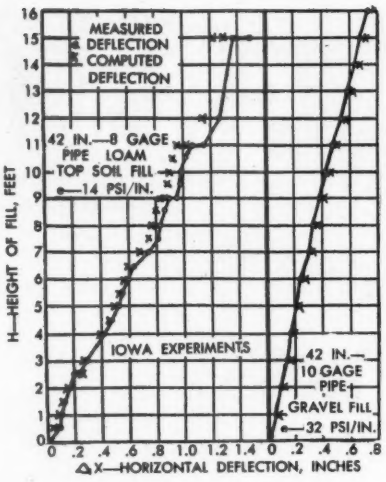


FIG. 12.

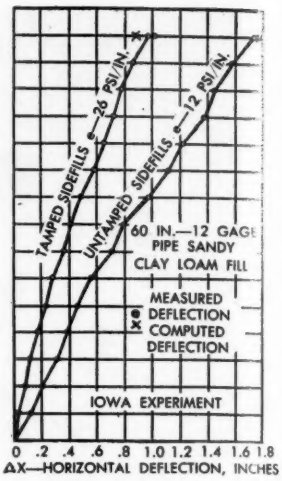


FIG. 13.

$$\Delta X = \frac{KW_c r^3}{EI + 0.061er^4} \quad . \quad . \quad (18)$$

Where:

ΔX = immediate horizontal deflection of pipe, in.
W_c = vertical load on pipe, lb per lineal in.
r = radius of pipe, in.
E = modulus of elasticity of pipe metal, psi.
I = moment of inertia of cross-section of pipe wall, in.^{4} per in.
e = modulus of passive resistance of side-fill soil, psi per in.
K = a parameter which is dependent upon the bedding angle. (Values of *K* are given in Fig. 11.)

Comparisons between the measured deflections and those calculated by equation (18) have been made in the case of 10 experimental flexible pipe culverts, which were loaded by earth fills at the Iowa Engineering Experiment Station and for 5 experiments conducted at the University of North Carolina.[11] The coincidence between the measured and calculated deflections in all 15 cases was very close; 9 of these comparisons are shown graphically in Figs. 12, 13, and 14. They are typical of all the experimental observations. These experiments also indicated that the vertical and horizontal deflections under fill loads were essentially the same.

The moment of inertia of the cross-section of the pipe wall per unit length of the pipe is one-twelfth the cube of the wall thickness. If we let t equal the wall thickness, in inches, and substitute $\frac{t^3}{12}$ for I in equation (18), an expression for the wall thickness in terms of a specified deflection, the vertical loads, and the properties of the pipe and of the soil may be obtained:

$$t = \sqrt[3]{\frac{1}{E}\left(\frac{12KW_c r^3}{\Delta X} - 0.732er^4\right)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

A phenomenon of considerable interest, which was revealed in the experimental studies, is the fact that flexible pipes continue to deflect slowly and for a long period of time after the maximum load from the overlying embankment has been reached. This continuing deflection has been called "deferred deflection," and is not revealed by equation (18). It is thought to be due to the fact that the sides fo the pipe exert a long sustained push against the soil side fills, and this sustained load causes the soil to compress slowly, even though there is no increase in the magnitude of load. The phenomenon is somewhat similar to the fact that a foundation often continues to settle into the soil for long periods after a structure has been completed and loaded. This lateral "settlement" permits a flexible pipe to deform after the maximum load has been reached. If it is desired to include deferred deflection in the calculation of pipe deflection, equation (18) can be empirically modified by multiplying it by a factor called the "deflection lag factor."

Thus:

$$\Delta X_1 = \frac{D_e KW_c r^3}{EI + 0.061er^4} \quad . \quad . \quad (20)$$

Where:

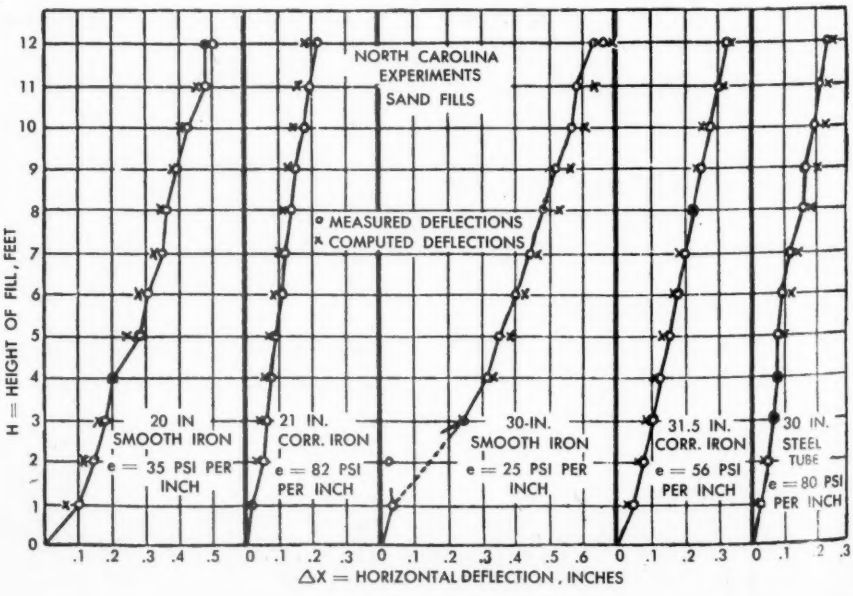
ΔX_1 = the ultimate long-time deflection of the pipe.
D_e = the deflection lag factor.

$$\Delta X_1 = \Delta X D_e \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

A very limited amount of experimental evidence indicates that a conservative value of the deflection lag factor is in the neighborhood of 1.25 to 1.50.

It is believed that equation (18) or the modified form, equation (20), can be used to predetermine the deflection of a flexible protective casing pipe at railroad crossings and serve as a means of choosing casing-pipe thickness that will prevent excessive deflection. Such an application requires employment of a number of assumptions, which will be discussed. Casing pipes are usually installed by tunneling under the railroad road bed at relatively shallow depths.

FIG. 14.


NORTH CAROLINA EXPERIMENTS
SAND FILLS
MEASURED DEFLECTIONS
COMPUTED DEFLECTIONS
20 IN SMOOTH IRON e = 35 PSI PER INCH
21 IN. CORR. IRON e = 82 PSI PER INCH
30-IN. SMOOTH IRON e = 25 PSI PER INCH
31.5 IN. CORR. IRON e = 56 PSI PER INCH
30 IN. STEEL TUBE e = 80 PSI PER INCH
H = HEIGHT OF FILL, FEET
ΔX = HORIZONTAL DEFLECTION, INCHES

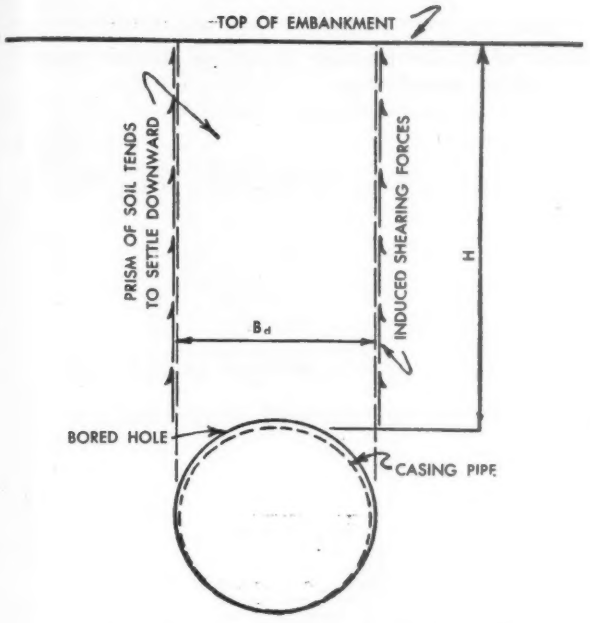


FIG. 15. Settlements which influence loads on casing pipe.

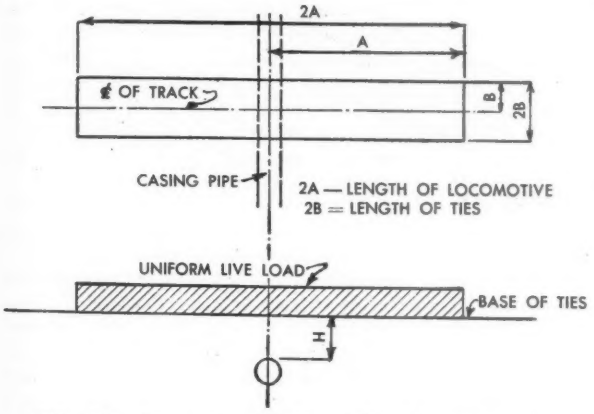
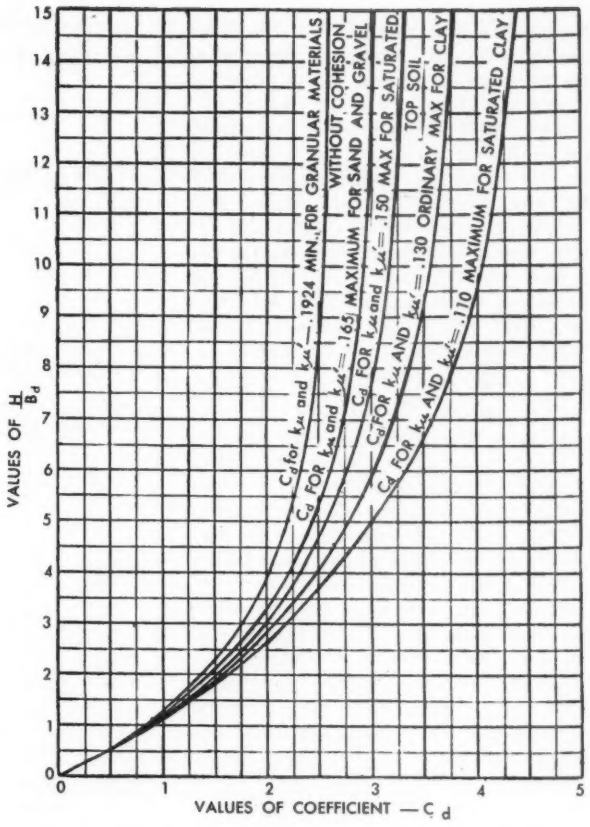


FIG. 17. Area over which weight of locomotive is distributed.


VALUES OF $\frac{H}{B_d}$
VALUES OF COEFFICIENT — C_d
C_d for k_{μ} and k_{μ}' — .1924 MIN., FOR GRANULAR MATERIALS WITHOUT COHESION
C_d FOR k_{μ} and k_{μ}' = .165 MAXIMUM FOR SAND AND GRAVEL
C_d FOR k_{μ} and k_{μ}' = .150 MAX FOR SATURATED TOP SOIL
C_d FOR k_{μ} AND k_{μ}' = .130 ORDINARY MAX FOR CLAY
C_d FOR k_{μ} AND k_{μ}' = .110 MAXIMUM FOR SATURATED CLAY

Load per Unit of Length, $W_c = C_d w B_d^2$ (Foot-Pound Units)
w = Unit Weight of Fill Materials
B_d = Breadth of Ditch at the Top of Conduit
H = Height of Fill over Top of Conduit

FIG. 16. Computation diagram for loads on "ditch conduits" (Completely buried in ditches).

say from 5 ft to 8 ft below the base of rail. This method of installation creates a very uncertain situation relative to the earth load which will actually develop on the pipe. It is conceivable that the bored hole in which the pipe is placed might retain its shape as a circular opening slightly larger than the casing, in which case there would be no load on the pipe either from the earth above it or the traffic on the rails. However, it seems more probable that the traffic loads and vibrations, climatic fluctuations, and moisture changes will cause the prism of soil above the bored hole to move downward until it rests on the casing—thus producing vertical load and acting as a medium through which the traffic loads may be transmitted to the casing pipe, as indicated in Fig. 15. This action would induce upward vertical shearing stresses along the vertical planes extending upward from the sides of the bored hole, and the load situation would be typical of the class of conduits described by Marston[4, 5] as "ditch conduits." The formula for load on a ditch conduit is:

$$W_d = C_d w B_d^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

Where:

W_d = load on conduit, lb per lineal ft.

w = unit weight of soil, lb per cu ft.

B_d = width of ditch or, in this case, the width of bored hole, ft.

C_d = a coefficient that is a function of the ratio $\frac{H}{B_d}$ and of the coefficient of internal friction of the soil above the pipe.

H = height of fill above the top of the pipe, ft.

Values of C_d for substitution in equation (22) may be obtained from Fig. 16.

Although the live loads are applied to the rails as concentrated axle loads, they will be distributed longitudinally by the rails and transversely by the ties. It is believed that the distributive effect of these elements is sufficient to warrant the assumption that the weight of a locomotive may be considered to be uniformly distributed over an area whose length is equal to the length of the locomotive and whose width is the length of ties, or 8 ft, as shown in Fig. 17. It is further assumed that this equivalent uniformly distributed live load is applied at the elevation of the base of the ties. Also, inasmuch as the live loads are dynamic in character, a suitable impact factor should be assumed for design purposes.

The author[7] has conducted experiments in which impact loads on buried conduits due to moving truck wheels operating at the ground surface were measured. These experiments definitely indicated that impact forces amounting to a substantial percentage of the static forces are transmitted through the overlying soil to a conduit below. However, the quantitative results are not applicable to the case of rail traffic because of differences in the traffic units and the track over which the units operated. In the absence of specific information relative to impact forces due to rail traffic, an impact factor of 1.75 will be assumed for the purpose of this study.

Having assumed the live load plus impact to be distributed uniformly over an area at the base of the ties, the unit pressure at a point on the top of the casing pipe directly beneath the center of the area may be estimated by means of

Newmark's integration[6, 10] of the Boussinesq equation. Newmark determined the pressure at a point in the undersoil at any elevation below one corner of a rectangular area over which unit loads are uniformly applied, and gave influence of coefficients corresponding to the ratios of: length of the loaded area over depth, and width over depth. To determine the unit pressure on the top of the pipe under the center of the loaded area, divide the area into four quadrants having a common corner at the center. Calculate the ratios

$$n = \frac{B}{H} \text{ and } m = \frac{A}{H} \text{ (see Fig. 17)},$$

and select the influence coefficient corresponding to these ratios from Fig. 18. Multiply this coefficient by the load per square foot on the loaded area. This product is the unit pressure on the pipe due to one quadrant of the loaded area. Inasmuch as there are four quadrants, each of which contributes to the load on the pipe, multiply this unit pressure by four to obtain the unit pressure produced by the total load. This procedure is widely employed in structural work to estimate the unit pressure on a deep soil stratum below a foundation, and it appears to be appropriate to the problem under discussion. Having obtained the load on the casing pipe due to the moving traffic, it should be added to the earth load obtained by equation (22) to obtain the total vertical load for which the pipe should be designed, or W_c in equation (20).

The vertical reaction on the bottom of the pipe will be distributed approximately uniformly over some width of pipe, depending on the width of contact between the bottom of the bored hole in the soil and the bottom of the pipe. If the bored hole were exactly the same diameter as the outside of the pipe, the width of contact would be the same as the outside diameter of the pipe; and the bedding angle, which is the angle a in Fig. 10, would equal 90 deg. As the diameter of the bored hole increases in relation to the diameter of the pipe, the width of contact between the pipe and the soil at the bottom decreases, and the bedding angle also decreases. It seems probable that, in some cases at least, the diameter of the hole might be enough larger than the pipe to justify an assumption of the bedding angle equal to about 60 deg; and a value of K corresponding to this value, as obtained from Fig. 11, is recommended as a conservative design value. Of course, if factual data relative to the width of contact between the pipe and the soil beneath it are available, such data should be used to select a value of the parameter, K.

Probably the most uncertain factor which enters into the computation of the deflection of a flexible casing pipe is the modulus of passive resistance of the soil at the sides of the pipe. In the researches conducted at Ames and at the University of North Carolina, a number of quantative measurements of this property of the soils involved were made, but much additional research is needed on this subject to establish clearly the nature and range of values of the modulus and the soil properties which influence it. Also there is some very vague evidence that the modulus may be dependent upon the size of the pipe and upon the stiffness factor, EI, of the pipe wall in addition to soil properties; but no conclusions in this regard are warranted at present.

Table 1. Values of modulus of passive pressure in various flexible pipe culvert installations.

Item number	Pipe diameter and type	Moment of inertia of pipe wall, I (in.^{4} per in.)	Side-fill soil conditions	Height of fill, ft	Modulus of passive resistance (Psi per in.)
	IOWA EXPERIMENTS				
1	42-in. 8-gage corrugated metal	0.005512	Loam top soil	15	14
2	42-in. 10-gage corrugated metal	0.004373	Well graded gravel	16	32
3	36-in. 16-gage corrugated metal	0.001848	Sandy clay loam (tamped)	15	28
4	36-in. 16-gage corrugated metal	0.001848	Sandy clay loam (untamped)	15	13
5	42-in. 14-gage corrugated metal	0.002326	Sandy clay loam (tamped)	15	25
6	42-in. 14-gage corrugated metal	0.002326	Sandy clay loam (untamped)	15	15
7	48-in. 14-gage corrugated metal	0.002326	Sandy clay loam (tamped)	15	29
8	48-in. 14-gage corrugated metal	0.002326	Sandy clay loam (untamped)	15	14
9	60-in. 12-gage corrugated metal	0.003317	Sandy clay loam (tamped)	15	26
10	60-in. 12-gage corrugated metal	0.003317	Sandy clay loam (untamped)	15	12
	NORTH CAROLINA EXPERIMENTS				
11	30-in. smooth iron	.....	Sand	12	25
12	31.5-in. 12-gage corrugated metal	0.003317	Sand	12	56
13	30-in. steel tube	.....	Sand	12	80
14	20-in. smooth iron	.....	Sand	12	35
15	21-in. 14-gage corrugated metal	0.002326	Sand	12	82
	OBSERVATION OF HIGHWAY CULVERTS IN IOWA				
16	36-in. 12-gage corrugated metal	0.003317	Heavy plastic clay (tamped)	11	51
17	36-in. 12-gage corrugated metal	0.003317	Surface soil	12.3	15+
18	72-in. 9-gage corrugated metal	0.005000	Old grade excavation (tamped)	10.5	10
19	54-in. 12-gage corrugated metal	0.003317	Clay and top soil (tamped)	8.1	14
20	60-in. 10-gage corrugated metal	0.004373	Sandy clay and top soil (tamped)	8.0	8

Several facts concerning the value of the modulus of passive resistance of side fills adjacent to the experimental flexible culverts have been observed. First, this modulus varies widely with soil characteristics. Measurements have indicated that the value for a well graded gravel material was approximately two to three times as great as it was in the case of a loam soil. Also, in the case of a sandy clay loam material, the modulus of passive resistance was approximately doubled by hand-tamping as compared to the value for the same material in a relatively loose shovel-placed condition. In the North Carolina experiments the side-fill material was described as a creek sand containing about 9 per cent moisture. The measured values of the modulus of passive resistance of the sand varied from about 25 to 82 psi per in. In some field studies of the performance of 5 actual flexible pipe culverts under highways in Iowa,[12] the values of the modulus were estimated to vary between a low of 8 psi per in. to a high of 51 psi per in. The highest value prevailed in the case of a 36-in. corrugated culvert pipe whose side fills consisted of a heavy plastic clay compacted with pneumatic hand-tampers. Measured and estimated values of the modulus for various soils and soil conditions are summarized in Table 1.

In all of the cases given in Table 1, the pipes were placed on the natural ground surface and then covered with an embankment. The soils at the sides of the pipe were, therefore, disturbed soils in a newly placed condition. In contrast, the soil at the sides of a casing pipe placed in a tunnel under a railroad track will be in a relatively undisturbed condition. There is no factual information available relative to the influence of this undisturbed condition on the modulus of passive resistance, but it seems reasonable to believe that the modulus would be higher than in the case of the same soil in a disturbed condition, even though the disturbed soil is well compacted when placed. In this connection it is pertinent to point out that the smaller the diameter of the bored hole in relation to the diameter of the pipe, the better will be the contact between the sides of the pipe and the soil, and a more favorable situation relative to the development of passive resistance pressures will be created than if the hole is too large. Also attention is directed to the fact that, in the experiments referred to previously herein, the loads on the pipes were produced by earth fills only. No live loads were applied at the embankment surface. In the case of a protective casing pipe, the live loads are a major portion of the total load, and these loads are applied repetitively. The influence of repeated loading on the modulus of passive resistance of the soil is not known.

The foregoing discussion of the modulus of passive resistance of soils emphasizes the wide range of possible values of this important factor in flexible pipe design, and the need for extensive research to develop a better understanding of its true character. On the basis of the author's knowledge and study of the factor, it is suggested that a value of about 30 psi per in. would be reasonably conservative for use in the design of casing pipes that are installed by tunneling under railroad embankments. This suggestion is purely tentative, and subject to revision from time to time as further knowledge and experience accumulate.

Example 1: A complete example of a procedure for determining the deflection

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of a smooth steel protective casing pipe under a railroad embankment, based upon the aforedescribed researches, will now be presented. It is emphasized that the purpose of this example is to illustrate a method. The numerical values of the various factors and properties used have been chosen arbitrarily for this purpose, and should not necessarily be considered as recommended values. The following conditions are assumed:

Inside diameter of pipe	29.25 in.
Outside diameter of pipe, B_c	30 in. = 2.5 ft
Mean radius of pipe, r	14.81 in.
Thickness of pipe wall, t	0.375 in.
Moment of interia, I	0.004395 in.^{4} per in.
Modulus of elasticity of metal, E	30,000,000 psi
Stiffness factor, EI	131,850 lb-in.
Vertical distance top of pipe to base of ties, H	6 ft
Unit weight of soil, w	125 lb per cu ft
Kind of soil	Moist to wet clay
Modulus of passive resistance, e	30 psi per in.
Bedding angle	60 deg
Bedding constant, K	0.09
Deflection lag factor, D_e	1.5
Live load, Cooper's E70 plus 75 per cent impact	

First determine the load due to the fill over the pipe by Marston's ditch-conduit load formula [equation (22)].

For this computation:

$H = 6$ ft

$B_d = 2.5$ ft $\quad B_d^2 = 6.25$

$\frac{H}{B_d} = 2.4 \quad w = 125$ lb per cu ft

From Fig. 16, using curve for "ordinary maximum for clay":

$$C_d = 1.8.$$

Substituting in equation (22):

$W_d = (1.8)\ (125)\ (6.25) = 1{,}405$ lb per lineal foot, or 117 lb per lineal inch.

Next determine the load on the pipe due to the weight of the locomotive plus impact. The weight of a Cooper's E70 locomotive is 497,000 lb. The length of the locomotive is 52 ft, and the length of ties is 8 ft. Therefore, in accordance with the assumption discussed several paragraphs back, the live load may be considered to be uniformly distributed over an area 8 ft by 52 ft at the elevation of the base of the ties. The unit load on this area, including impact, is:

$$\frac{(1.75)\ (497{,}000)}{(8)\ (52)} = 2090 \text{ lb per sq ft.}$$

Using Newmark's integration of the Boussinesq formula and dividing the loaded area into four quadrants:

$$n = \frac{26}{6} = 4.33.$$

$$m = \frac{4}{6} = 0.67.$$

From Fig. 18, the influence coefficient corresponding to these ratios is 0.16. Then the unit pressure on top of the pipe at a point directly under the center of the loaded area is:

$(4)\ (0.16)\ (2{,}090) = 1{,}338$ lb per sq ft.

Assuming this pressure is uniformly distributed over the top of the pipe, the load per lineal inch is:

$$W_e = \frac{(1338)\ (2.5)}{12} = 279 \text{ lb per lineal inch.}$$

The total load on the pipe is:

Earth load, W_d 117 lb per lineal in.

Live load plus impact, W_e 279

Total load, W_c ..... 396 lb per lineal in.

The computation for ultimate deflection by equation (20) is:

$$\Delta X_1 = \frac{(1.5)\ (0.09)\ (396)\ (14.81^3)}{131{,}850 + 0.061\ (30)\ (14.81^3)} = 0.79 \text{ in.}$$

This indicates that the maximum long-time deflection of the 30-in. by 3/8-in. steel pipe will be 0.79 in.

Example 2: Determine the thickness of a 24-in.-OD casing pipe whose ultimate deflection will not exceed 1 in. Assume all quantities to be the same as used in example (1), except the pipe diameter and wall thickness. Calculate the dead load and the live plus impact loads in the manner employed in example (1). The total load on the pipe is 311 lb per lineal inch.

Next assume a tentative wall thickness of 1/4-in., which gives an inside diameter of 23.5 in. and a mean radius of pipe of 11.88 in.

Then, inasmuch as ΔX_1 equals 1 in.:

$$\Delta X = \frac{\Delta X_1}{D_e} = \frac{1}{1.5} = 0.67 \text{ in.}$$

Substituting in equation (19):

$$t = \sqrt[3]{\frac{1}{30{,}000{,}000}\left[\frac{(12)\ (0.09)\ (311)\ (\overline{11.88^3})}{0.67} - 0.732(30)\ (\overline{11.88^4})\right]} = 0.24 \text{ in.}$$

This computation indicates that the 24-in. pipe should have a wall thickness of 1/4-in. in order that the deflection will not exceed 1 in.

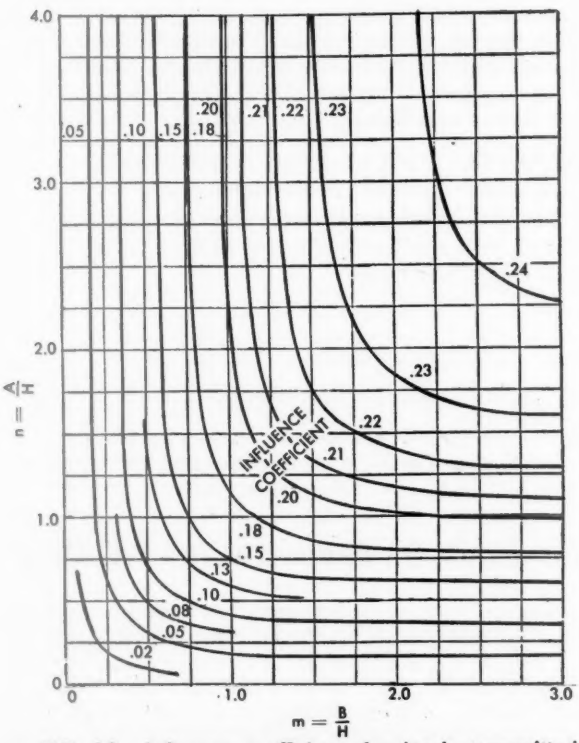

FIG. 18. Influence coefficients for loads transmitted through soil.

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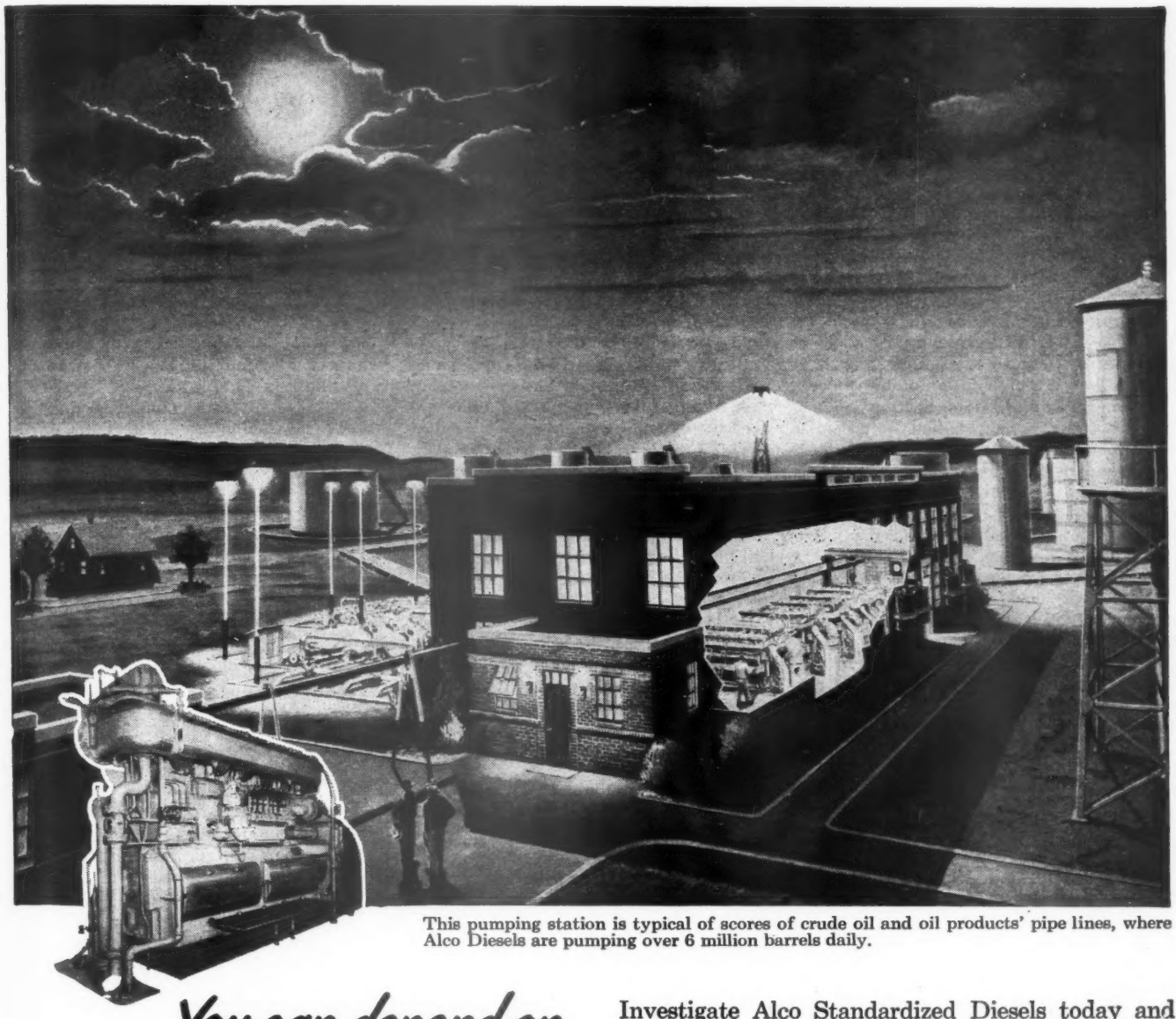

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PAD's Survey of Transportation Needs

Data on existing facilities and possible future oil movements serve as guide in allotting materials

A COMPREHENSIVE, detailed study of petroleum transportation in the nation, the first such study ever prepared, has been made public by Acting Deputy Petroleum Administrator Alfred P. Frame.

Completed in mid-1951, the study has been used by the Petroleum Administration for Defense and other federal agencies as a guide in planning since that time. Changing mobilization goals for the country have called in recent months for an upward revision of some of the expansion goals set in the report, Frame said. "But the basic approach and methods of the study remain completely valid," he added, "and the figures in it have served and will continue to serve their purposes."

The study covers facilities for the movement of petroleum and its products by pipe line, tanker, barge, tank car, and tank truck. It sets out an inventory of those facilities as they existed in 1951 and projects expected mobilization needs in the fields through 1952 as those needs were seen at the time of the study. It also indicates in general terms the volume of oil it is expected will have to be moved through 1955.

A final chapter contains a survey of the needs for expansion of bulk storage space for oil through 1952. Figures in this chapter also have been revised sharply upward since completion of the study.

Eight specialists, all consultants to the Petroleum Administration for Defense, made the study for the agency over a five-month period under the direction of John W. Boatwright.

Continuing surveys are being made, Frame said, to keep the data in the report current. Meanwhile the study has been used by PAD over the past six months as a factor in determining allotments of controlled materials for which it is a claimant agency.

"This study," Frame emphasized, "is based on an assumption that mobilization needs will continue but that there will be no all-out emergency. Transportation requirements would change radically in the event of full-scale war.

"One thing must be borne in mind above all others: This is a report, not a program.

"Assumptions necessarily had to be made at the time of its preparation, particularly assumptions about the probable growth of demand for petroleum and its products. Some of those assumptions have since had to be revised in light of the revision of mobilization programs, and so the report now constitutes a study of facilities, not a plan for their expansion.

"Many of the goals set out in the report, as a matter of fact, already have been reached, and the facilities for the realization of still others are at the stage of firm planning. But this does not mean that PAD's work in this field is at an end. Much more remains to be done to meet the expanding mobilization needs."

The report is based on an estimate that the demands for petroleum in the United States in 1952 will be for an average of 7,623,000 bbl a day; that U. S. refining capacity will be 7,482,000 bbl a day, and that the availability of crude oil and natural gas liquids in the nation will be 7,692,000 bbl a day.

If the demand is to be met from the available supplies, the report says, there will have to be significant increases in all domestic transportation facilities.

Specific findings in the report for each of the various types of transportation—all as of mid-1951, not as of the present—are the following:

Tank Trucks

1. *Tank trucks* (only those used in over-the-road petroleum transportation, not in local marketing alone).

The report establishes a January 1, 1951, inventory of 10,692 straight trucks (single units of 2000 to 3000 gal capacity) and 26,783 trailers and semitrailers.

To meet future demands, the report says, this fleet will by the end of 1952 have to be expanded by 1538 straight trucks, 5555 semitrailers and trailers, and 8400 tractor units.

In addition it is estimated that 1800 straight trucks and 1883 trailers and semitrailers are required to replace scrappage during 1951 and 1952.

Tank Cars

2. *Tank cars.* The report establishes a January 1, 1951, inventory of 84,523 general-purpose tank cars (including about 3500 United States-owned cars operating in Canada) and 10,302 pressure tank cars in petroleum service.

By the end of 1952, the report says, the general-purpose fleet should be expanded by 2000 cars; the pressure-car fleet by 4700 cars to meet an expected continued rapid increase in the demand for liquefied petroleum gas.

It is estimated that 4200 general-purpose cars are required to replace scrappage during 1951 and 1952, but scrappage of pressure cars is believed to be negligible.

Pipe Lines

3. *Pipe lines.* The report estimates that 180,000 tons of steel are required for pipe for crude oil gathering lines during 1951 and 1952, with 90,000 tons allocated in each year.

In addition it recommends that the following amounts of steel be given during the two-year period for the following domestic crude oil trunk lines:

	Tons of Steel
Sheridan, Indiana, to Lima, Ohio	23,000
Cushing-Drumright, Oklahoma are to junctions in the vicinity of Kansas City	90,000
Junctions in the vicinity of Kansas City to Chicago	65,000
West Texas to Drumright loops	20,000
West Texas to east Texas and Beaumont	130,000
West Texas to Houston	125,000
Louisiana Gulf to Texas Gulf Coast	55,000
Clear Brook, Minnesota, to St. Paul	18,000
Indiana-Ohio area to central Michigan	12,000
Borger, Texas, to Yale, Oklahoma	22,000
Mississippi fields to Mobile	10,500
Wyoming to Wood River, Illinois	188,000
Miscellaneous extensions	116,000

Total steel required for these domestic trunk line projects is 874,500 tons.

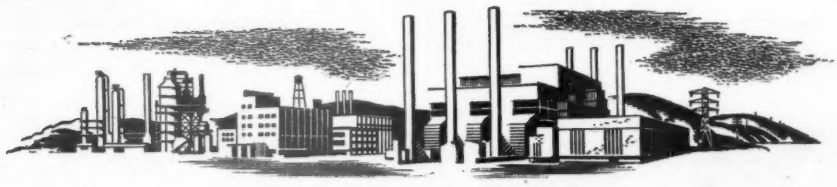
The report also recommends that 305,000 tons of steel be used in building various product pipe lines.

No requirements for maintenance pipe were included in the estimates, and all the recommendations are for use of new—not second-hand—pipe.

Many of the recommended allocations already have been made, Frame pointed out, although the limited quantities of steel available have made fulfillment of the complete program impossible to date. All recommendations, he said, were based on a triple consideration: (1) The necessity for moving as much of the crude oil and products as possible from the place of origin to the points of potential use; (2) the need to use limited quantities of steel as efficiently as possible, and (3) possibilities of the interruption of some normal channels of petroleum movement in the event of an all-out emergency.

Tankers

4. *Tankers.* As of 1950, the report says, the capacity of all tankers, worldwide, available for commercial petroleum trade was the equivalent of 1199 T-2's. A T-2 is defined as a petroleum carrier of 16,765 deadweight tons with a speed of 14.5 knots. For 1951 the esti-



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mated average of available capacity was 1311 T-2's, and the 1952 average is estimated at 1416 T-2's. These estimates were prepared from construction programs underway. Indications are, the report says, that there will be a tight tanker supply situation throughout this winter.

Storage

5. *Storage.* Additional storage requirements for 1951 and 1952 are conservatively estimated to be the following:

	At refineries, bbl	Pipe lines, tank farms terminals, bbl	Total, bbl
Clean products...	21,100,000	31,000,000	52,100,000
Residual fuel.....	4,300,000	1,200,000	5,500,000
Other products...	1,500,000	1,800,000	3,300,000
Crude petroleum.	9,600,000	14,700,000	24,300,000
Total.....	36,500,000	48,700,000	85,200,000

Construction of such additional storage, the report says, would require 426,000 tons of steel — 260,500 for clean products, 27,500 for residual fuel, 16,500 for other products, and 121,500 for crude petroleum.

Included in the survey report are six appendices that set out in detail the basic data and the statistical methods used in arriving at the conclusions and recommendations of the report.

"This is something of a monumental study," Frame said. "We believe it is a distinct contribution to the defense effort because its basic data will help the oil industry gear its planning to the mobilization drive. Certainly we are grateful to all who made the study possible."

The eight specialists who made the study under Boatwright's direction are:

Minor S. Jameson, Jr., assistant to the president, Independent Petroleum Association of America.

Benedict Saurino, statistical economist, Sun Oil Company, author of "World Tanker Fleets, 1900 to 1945."

Thomas T. Allen, former supervisor of inland-waterways fleet for Standard Oil Company (Ohio), present member of Ohio Standard's crude oil purchasing department.

Frederick S. Lott, former chief of the Petroleum Economics Branch of the United States Bureau of Mines, now assistant to the director, PAD's Supply and Transportation Division.

Paul D. Fell, assistant chief engineer, Sinclair Pipe Line Company.

Frank C. Perry, staff member of the transportation department, Atlantic Refining Company.

Walter A. Powers, assistant chief of railway transportation for PAD.

Donald A. Brew, on leave from post as economic analyst in the comptroller's department, Standard Oil Company (California).

Boatright is general manager of the Distribution Economics Department of Standard Oil Company (Indiana). ★ ★

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And these qualities pay off. Many of this country's pioneer oil and gas pipe lines—laid in the 1920's—are still giving good service today, thanks to the effective protection provided by Bitumastic Enamels.

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Unloading pipe sections alongside ditch.

Use Of Aluminum Pipe In Oil Country Applications

WILLIAM B. MOORE, JR.

THE family of companies known as the petroleum industry is one of the largest in the world. Each year it consumes tons of material at gigantic cost. Various suppliers furnishing materials to the petroleum industry are constantly attempting to improve their quality and to introduce new and better products. Typical of this effort is the attempt to supply metals more satisfactorily meeting its needs. In improving the quality of this metal supply, new alloys are introduced, old ones are reapplied, and new metals tested. High among the many challenging requirements encountered are better corrosion resistance, lighter weight, higher strength, reduced pipe frictions, and lower costs.

Aluminum is beginning to take its place among the metals best suited to petroleum service. At present, large quantities of aluminum are used in the oil country for tank decks, drillable castings, casing windows, pipe wrap and insulation, condenser tubes, cathodic protection anodes, non-sparking nails, building products, electrical conductor, light-weight pulleys, pumps, and widely varying forms of pipe and tubing. The following discussion will deal primarily with the present and proposed uses of aluminum pipe and tubing.

The Author

William B. Moore, Jr., attended Mississippi State College and obtained a BS degree in chemical engineering at the University of Louisville, followed by an MS degree at the same school. He was employed as chief engineer of the Institute of Industrial Research at the University of Louisville. He joined Reynolds Metal Company as technical service engineer and recently was named assistant to the vice president in charge of product and market sales development. He has done considerable development work in the application of aluminum in the chemical and petroleum industries and is the author of a number of treatises on the subject.

Aluminum tubular products are produced by extrusion and, in certain instances, further processed by drawing or tube reducing. Extruded pipe and tubing has many good points. First, it is seamless. In addition, its smooth inner surface makes available a low fanning friction factor. For applications requiring extremely close dimensional tolerances, drawn tubing is utilized.

Aluminum pipe and tubing are available in a variety of alloys and tempers, ranging from 2S-O having a tensile strength of 13,000 psi to 75S-T6 with a 90,000-psi tensile strength. The alloys found most suitable for oil country tubular application are 63S-T5 and 61S-T6. Typical properties of these alloys are listed in Table 1.

Table 1. Typical physical properties of two aluminum alloys.

Alloy	Tensile strength, psi	Yield strength, psi	Elongation, per cent
63S-T5	30,000	25,000	12
61S-T6	45,000	40,000	17

At the present time aluminum tubing and pipe is being used successfully in the following petroleum industry applications.

Heat Transfer Equipment

One of the outstanding uses for aluminum tubing and pipe in the petroleum industry is in the equipment classified as heat transfer. This category includes condensers, all types of heat transfer equipment, evaporators, tank, suction heaters, etc. Of the more than 100 different processes involved in the production, transportation, and refining of petroleum products, heat transfer is of primary importance both in heating and cooling these products.

Aluminum is highly resistant to corrosion and has a high heat conductivity. Especially interesting to the refiner is the fact that aluminum displays a remarkable resistance to sour crude corrosion. In applying aluminum to sour crude service, care must be exercised to prevent the concentration of heavy metallic sulfides on the aluminum and to insulate it from contact with metals having a different electro-chemical potential.

In addition to the initial thermal advantage to be obtained in designing for aluminum's high coefficient of heat transfer, is the fact that formation of rust is eliminated and scale formation is minimized, assuring a high rate of heat transfer throughout the life of the aluminum tube.

In the production of oxygen for the low temperature synthesis of gasoline, aluminum has been found economical for heat exchange. This is because the

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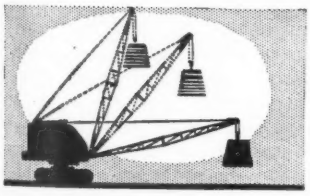
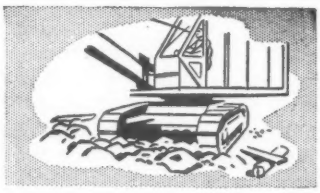
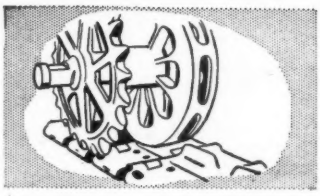


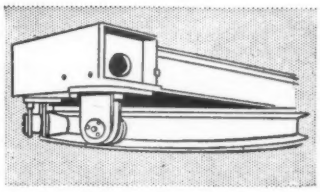
Independent Boom Hoist — controlled power *down* as well as up. *Safer*, faster. Boom, hoist, swing simultaneously or independently.



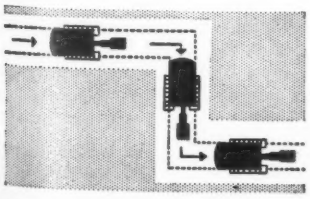
High Ground Clearance — eliminates snagging or fouling in rough areas. No projecting castings or easily damaged parts.



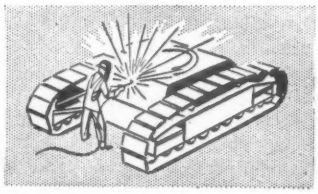
Self-Cleaning Crawler Treads — eliminate compacting. Track shoe lug meshes with pocket in the drive wheel—ejecting material.



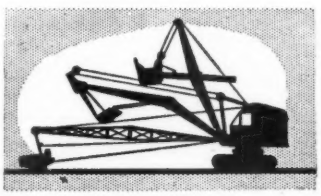
Hook Rollers — Cone-shaped for *true* rolling. Reduce roller and roller path loads—eliminate center pin pull.



Turns on a Dime. Either track can drive or be locked independently. Digging brakes controlled from cab.



All-Welded Lower — extra strength without extra weight. Resists impact and twist. Field service simple, fast.



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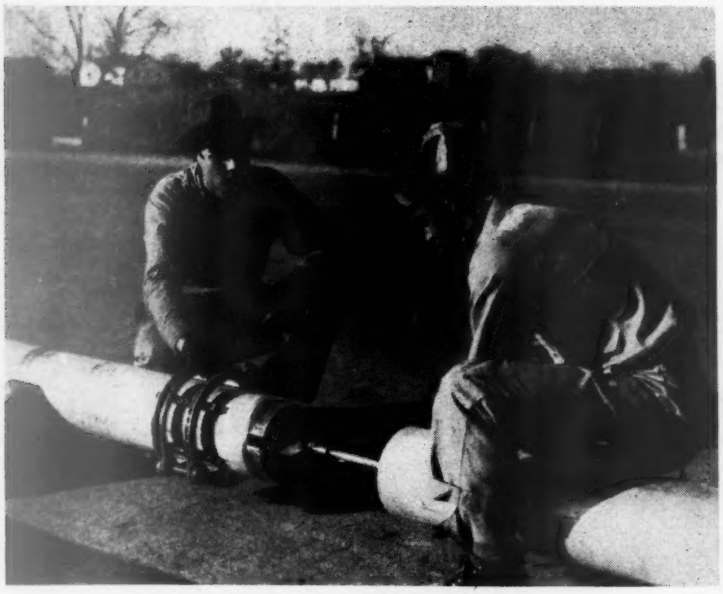


Back-up is provided by a chill ring. After welding, it is collapsed and withdrawn.

Bell-hole welding the 200-ft lengths of pipe into the line.

various mechanical properties of aluminum, such as impact strength, tensile, yield strength, and elongation, actually increase with decreasing temperature.

Shot Hole Casing

Light-weight aluminum shot hole casing is used by exploration companies. Although costing more than casing made from heavier metals, the aluminum weighs about 1/6 as much. In addition to the obvious ease of handling, a high hole recovery is obtained with this roll-thread light-wall aluminum casing.

Temporary-Portable Lines

Temporary fuel transportation and gathering systems of very light-wall aluminum pipe are gaining in popularity due to their light weight. Such systems are being used to transport water, air, and other fluids to drilling rigs, and as aboveground, low pressure gathering systems for gas and crude oil. Table 2 gives the weights of 4-in. light-wall aluminum pipe. The ratio of standard iron pipe weight to aluminum pipe is approximately 15 to 1.

Table 2. Weights of 4-in. aluminum pipe.

Nominal size	4
O D, in.	4.000
I D, in.	3.950
Wt. per ft	0.73

Aluminum Pipe Lines

The outstanding application of aluminum in the petroleum field is in pipe lines for gas and oil. The factors of corrosion resistance, light weight, and reduced fluid friction inherent in an extruded aluminum pipe has long been of interest to engineers and executives concerned with the transportation of gas and oil. In recent years, therefore, several test installations of aluminum pipe have been made in order that the adaptability of aluminum to this service might be illustrated. Test lines have been operating in Arkansas and Louisiana for several years and additional lines recently have been installed in northern Alabama, Oklahoma, and Texas. The tests are carrying sweet crude, sour crude, and natural gas.

One line, approximately two miles long, was installed by the Alabama-Tennessee Natural Gas Company in Florence, Alabama. It is carrying natural gas at approximately 250 psi and consists of 8-in. extruded pipe. The alloy used is 63S-T5, which gave the pipe line a bursting strength of approximately 1400 psi after welding. Another line of aluminum pipe was installed by a large oil company in Oklahoma. Here, 300 ft of 10-in. pipe was used to make up a suspended river crossing near Bowie.

In analyzing the cost of the Alabama-Tennessee Natural Gas Company's line and the other buried aluminum lines, the cost of installing aluminum pipe was found to be approximately 30 per cent less than that for installing the presently utilized material. The light weight of the aluminum pipe made possible savings in the stringing operation, handling during welding, lowering in, and other operations. The already clean surface of aluminum pipe made it unnecessary to clean before wrapping, and effected a saving in wrapping and coating.

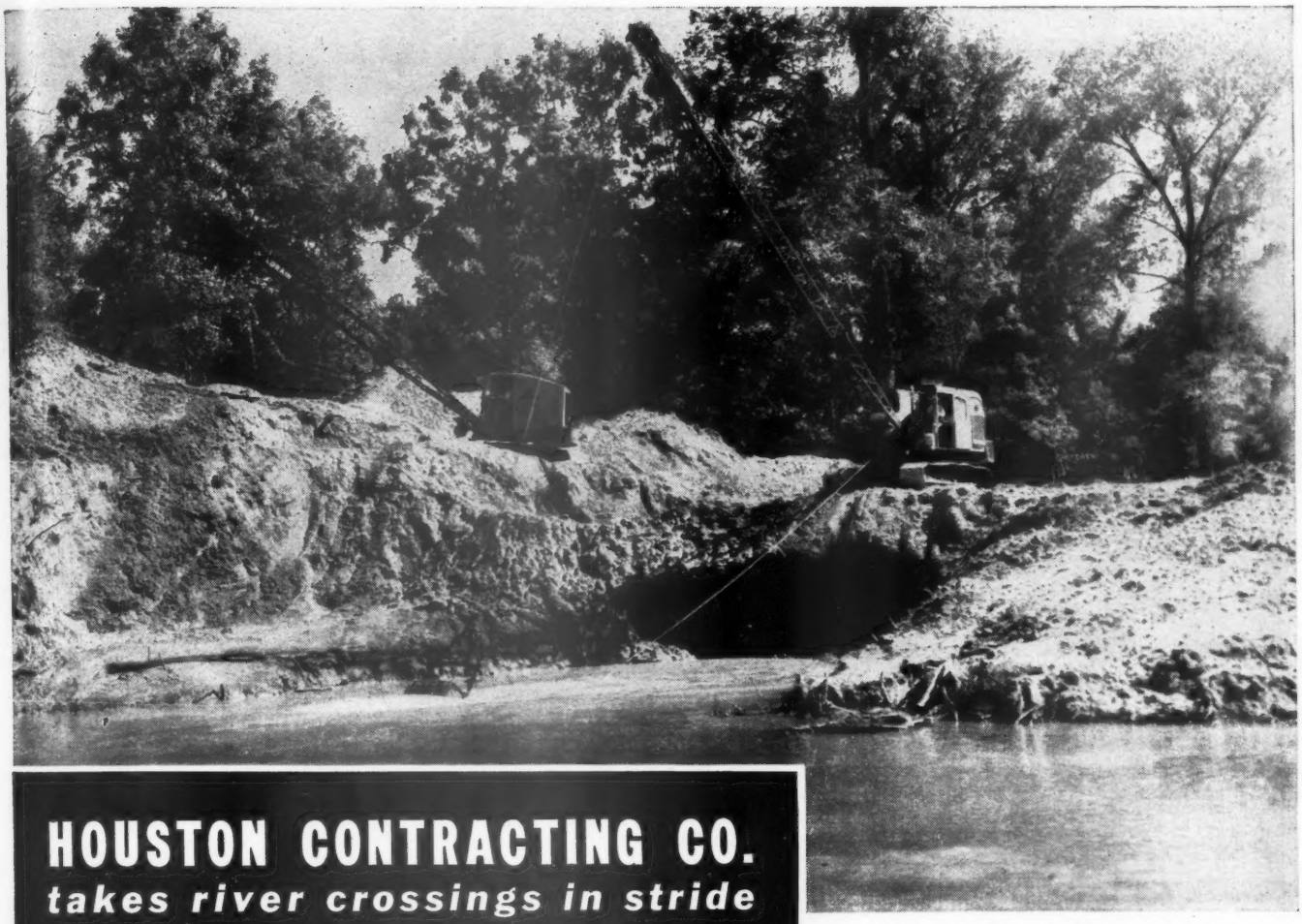
The 8-in. aluminum pipe used by the Alabama-Tennessee Natural Gas Company weighed approximately 320 lb per joint. This pipe was strung along the right-of-way by two men walking beside a lowboy carrying the pipe, as fast as the men could walk. In welding, the pipe was roll-welded in 200-ft sections in order to eliminate time-consuming bell holing. Another factor contributing to the faster welding, was the ability to line up the joints by hand. After welding, the 200-ft joints were placed over the ditch and joined by the bell hole welds. This method of welding effected a sizable saving.

In making the river crossing mentioned, a light weight suspension was placed across the river and the 30-ft joints of aluminum pipe were welded and pushed out onto it. By using this method, the crossing was installed entirely from one side of the river.

The aluminum pipe line tests show that aluminum has high corrosion resistance to many types of soil. In certain soils, aluminum pipe may be installed bare with no danger of corrosion damage. Low friction factor of aluminum pipe leads to low pumping costs.

Of the conditions favoring the use of aluminum pipe, the most obvious is that in any type of suspended crossing the light weight of the pipe makes possible a cable and cable support design. Experience with these crossings indicate that the low cost of this structure will offset the additional cost of aluminum pipe in the average length crossing. Further savings are, of course, made in the relative ease with which the aluminum pipe is

Welding the flange on one end of the aluminum pipe.



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THEW® LORAIN PIPELINER

To obtain more information on products advertised see page E-51

Coating "dope" is applied by hand before wrapping the pipe.

Wrapping safeguards against outside corrosion. A 6-in. strip is wound with slight lap.

handled and the fact that aluminum needs no protection from atmospheric corrosion.

In general, conditions favoring aluminum are those requiring installation costs high enough so that the savings in installation will offset the increase in cost of material.

Table 3. Costs of 8-in. aluminum pipe line.

Installation costs per ft	$ .60
Material cost per ft	2.35
Total cost per ft	$ 2.95

In ideal terrain the relative installation and material costs for 8-in. welded, coated, and wrapped lines can be approximated as shown in Table 3.

In this ideal terrain the total cost of an aluminum line is some 27 per cent greater than a standard steel line. It has been determined, however, in several installations that the ratio of installation costs remain essentially constant with aluminum being about 30 per cent less expensive to install. Thus the break even point, or the type of terrain that will so equalize this installation cost advantage, must be considered. (See Table 4.)

Still using the 8-in. line as a means for illustrating the economics involved in the selection of aluminum pipe, it is seen that in mountainous, marshy, underwater, or otherwise inaccessible terrain where installation costs approach or exceed $2.50 per foot, aluminum pipe can be used to advantage. Unless unusual circumstances prevail, aluminum pipe can be put in at a definite overall saving in such locations. It should also be pointed out here that these estimates are based on the utilization, to a great extent, of existing methods and equipment. Developments in the years to come will probably lead to new and better ways and equipment for the installation of aluminum pipe.

Single cable is sufficient support for aluminum gas pipe river crossing. Roller type cable supports are at 30-ft intervals.

Table 4. Costs of 8-in. aluminum pipe lines.

Installation cost per ft	$ 1.68
Material cost per ft	2.35
Total cost per ft	$ 4.03

Light weight, strong, smooth-walled, corrosion-resistant aluminum pipe is now a factor worthy of selective consideration by the pipeliner. Under existing pricing it is not meant to be competitive with steel for pipelining in ideal terrain. When a job, however, calls for rough going in mountains or swamps, marshes or under water, wherever it is difficult and costly to move men and equipment, aluminum has many economic advantages. ★ ★ ★

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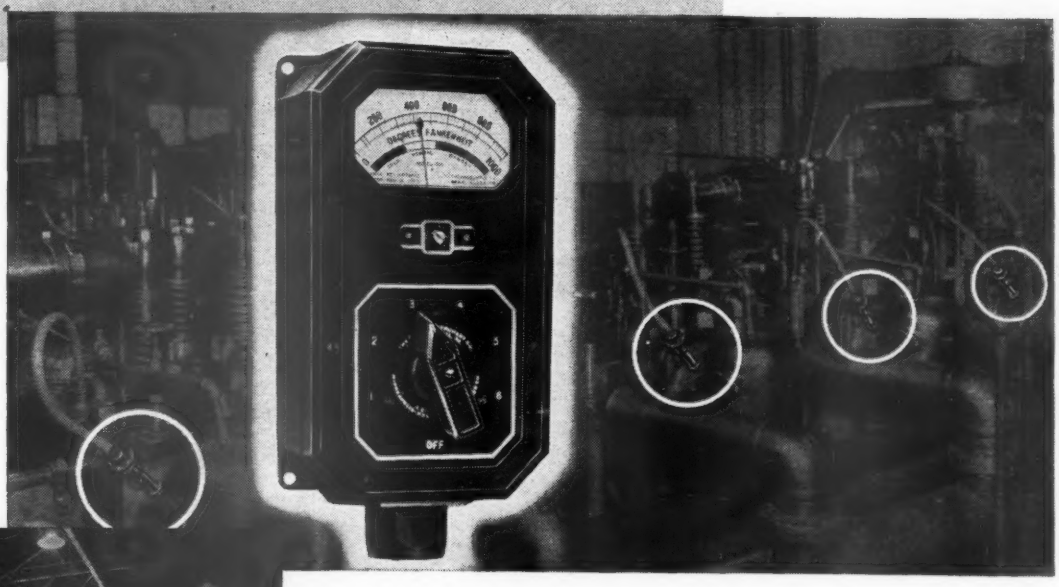

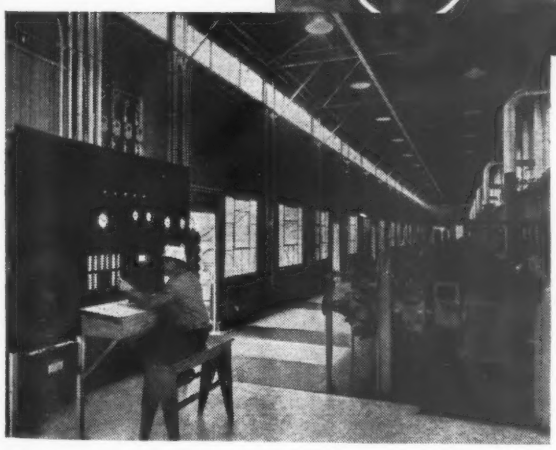

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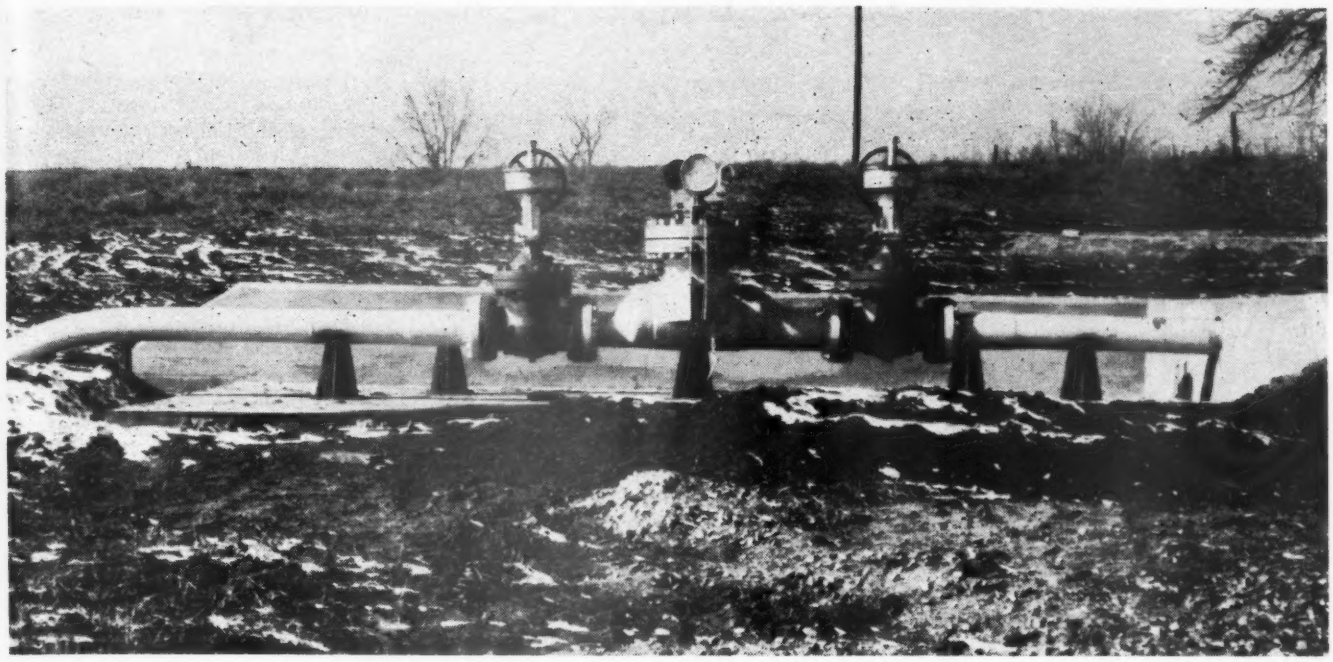


FIG.1.

The Wear-Compensating Pipe Line Scraper

Within a span of comparatively few years scraper design has advanced enormously and the program of improvement continues

B. VER NOOY

EVERY branch of the pipe line industry has made a great deal of progress in the last few years. It is reflected in the increased total pipe line mileage, the increased volumes of materials moved, and the increase in capacity of existing facilities. A large part of this has come from the programs of research and development as applied to pipe lines by several major oil companies. These projects were usually aimed at the solution of a specific problem or group of problems and it has become increasingly evident to the companies concerned that the solution of every problem encountered or attacked is not all-important. The important thing is that some solutions are found, many facts are brought to light, and the industry is helped as a whole. The modern pipe line scraper is one example of this progress.

In January, 1946, a project to study methods of improving the condition of the interior of products pipe lines was undertaken. One phase of this project, to be conducted by Plantation Pipe Line Company, was "mechanical conditioning". The program was carried on under agreements with the Standard Oil Development Company, as Plantation was, at that time, an affiliate in the pipe line research program. Two significant results were obtained, one of which was later found to cancel the need for the other.

On Plantation's 8-in. pipe line from Bremen, Georgia, to Knoxville, Tennessee, there were two stretches, each about 100 miles long with no intermediate facilities for scraper replacement. The condition of these lines, as far as pumping capacity or C-factor was concerned, was below the generally good flow characteristics found in the rest of the system. The condition of the scrapers run through these sections showed that they were worn out long before they reached the end of the line. Thus, first consideration was given to the installation of conventional scraper traps at the middle of the long runs. Such traps would have allowed for removal of worn scrapers and insertion of reconditioned ones, but also would have required the presence of personnel at each location when scrapers were to be received or launched. Instead, a "tee" type of trap

EXCLUSIVE

The Author

B. Ver Nooy has been chief engineer of T. D. Williamson, Inc., for the last three years. Previous to this he worked with Ford, Bacon and Davis, Inc., and Plantation Pipe Line Company, first on original construction, later in operations and in design and installation of new facilities, and finally as engineer in charge of economic studies.

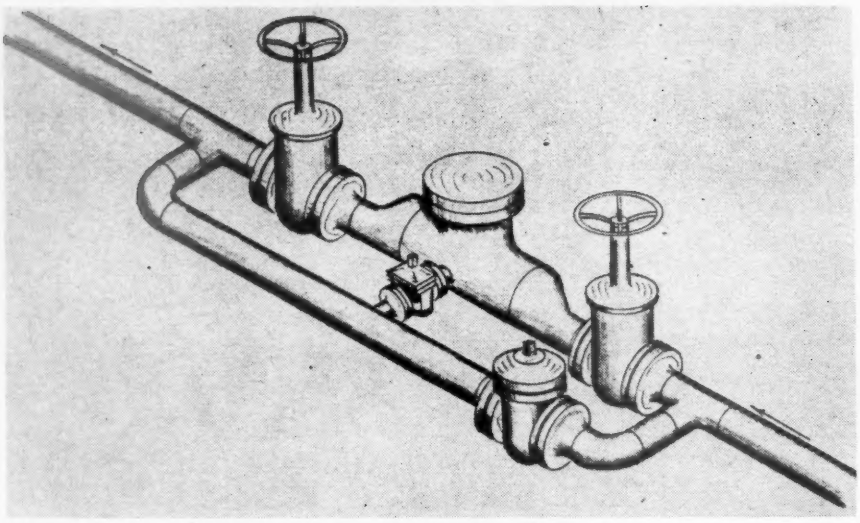


FIG. 2.

was developed and installed at each location (as shown in Fig. 1 and Fig. 2), which would allow the scrapers to take care of themselves.

This trap featured "straight-through" piping with no discernable pressure drop and one-man operation with removal and insertion of scrapers through the same flange. By varying either the flow or the bypass openings, as well as the loading, the trap could be set at convenient times to take care of scrapers at any time. With the bypass closed the scraper would pass through the trap with only a slight pause; with the bypass open the scraper would stop in the trap for removal at some later time. If a new scraper had been previously installed it would leave the trap when the old one arrived.

An added advantage was the lack of need for any drainage facilities, as any operation could be completed without drainage of the barrel or bypass. These intermediate traps were found to be of particular value when this line was operated to balance the rest of the system and pumping rates (and therefore scraper arrival times) were subject to change on short notice. Their value was limited, however, when scrapers were run in groups, because, although the trap could receive three or four scrapers, only one could be safely pre-installed for launching. With intermediate scraper traps the brushes and cups of the scrapers could be replaced twice as often, but it became obvious that trap spacing would have to be in the nature of 10 or 12-mile intervals to insure continuous good contact with the pipe surface.

Several types of tools were in general use at that time. One was a cup-brush type with flat wire bristles mounted in half-rings held in place by grooves in the adjacent flanges. The brushes when new were about $\frac{1}{8}$-in. larger than the inside diameter of the pipe, but were worn to about $\frac{1}{4}$ in. or $\frac{1}{2}$ in. less than pipe diameter after the 100-mile run. A photo of this scraper is shown in Fig. 3. As this early type of scraper usually suffered from pronounced wear on the bottom side, a modification (Fig. 4) was tried that was equipped with tangentially mounted nozzles on the nose end. The function of these jets was to rotate the tool and distribute the wear. As the brush and cup life were definitely increased, it is obvious that this rotation was accomplished and was helpful. (Note that the scraper was not intended to spin; if it had, it would have worn out faster.) It has been estimated that the rotation is in the nature of one revolution every 5 to 25 miles depending on flow (both through the pipe line and through the scraper), pipe line characteristics, fittings, and scraper condition.

A third type of scraper, which has probably found its way into everybody's pipe line at one time or another was a "club-sandwich" of rubber disks and wheel-type brushes. It had the advantage of being the least expensive design, but it also had several disadvantages, including an excessive weight per square inch of support and accompanying excessive wear per mile of travel. The largest bristle available was 0.014 in. round wire and the length of bristle made it so flexible as to be relatively ineffective from either the support or cleaning standpoint. Later experiences have shown this wheel-type brush to be really effective only when the brushes are compressed tightly together on small size (under 6 in.) cleaning tools. A photo of this plug is shown in Fig. 5.

The final type was an old favorite of pipe liners for many years. Fig. 6 shows the go-devil as used by many lines. The type of deposit removed from Plantation's system was composed largely of powdered rouge and ordinary earth with some small particles of scale. If any of these particles were adhering to or lying on a metal surface, the obvious hand tool to remove them would be a wire brush, not a knife. With this reasoning in mind, it was not felt that blades were adaptable to the type of cleaning required in a products line. The fact that the go-devil actually did not bring in appreciable amounts of debris and the more important high rate of failure and subsequent stoppage in the line have since made it obsolete for products systems.

The aims of this program were then transferred to the development of a scraper that would have the following characteristics:

(1) It must compensate for wear because a scraper having brushes that do not exert a positive pressure against the pipe wall does not clean effectively; (2) it must be light weight for maximum brush life; a heavy tool requires greater support area (thus adding more weight) or it will wear out quicker; (3) it must be simple and have few parts because a multiplicity of parts increases the chances of failure in the line, frequency of mistakes in assembly, and cost of

FIG. 3.

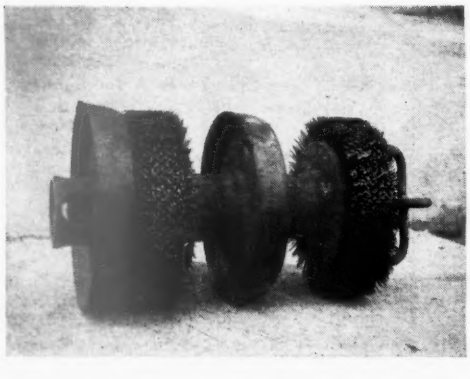
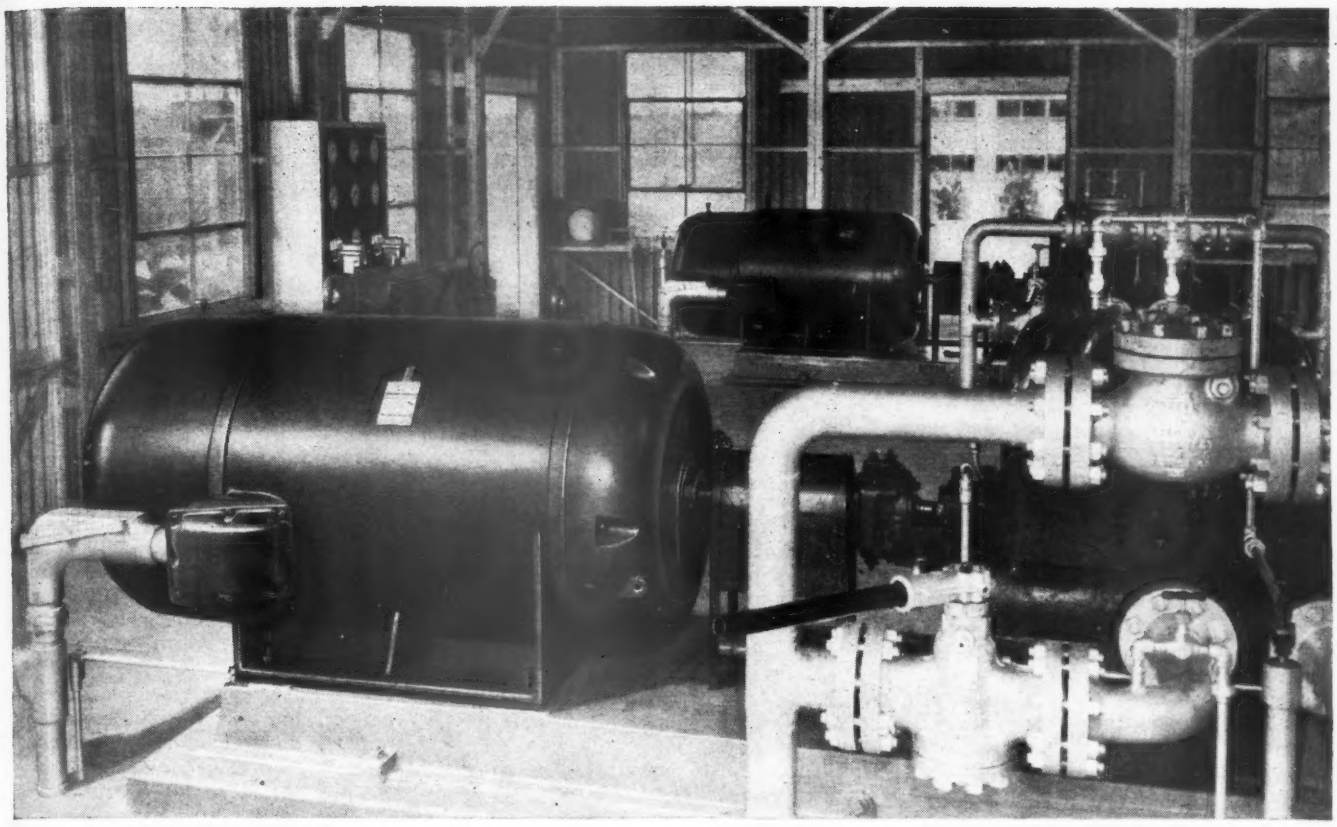


FIG. 4.

FIG. 5.



Driving the main pumps in a Texas pipeline station, these two G-E explosion-proof induction motors—each rated 350 hp—are controlled either from master panel in control building outside or from the two G-E explosion-proof push-button starters at left.

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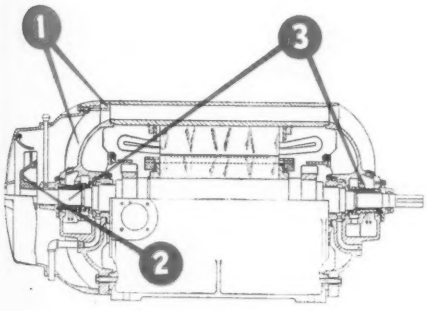

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maintenance; (4) last, but by no means least, the basic design must be proportioned to facilitate the passage of the tool through the valves and fittings it must traverse. One basic fault of the old jointed tools was that the individual sections were not self-supporting through valves and fittings—their passage being more by chance than by design.

The scraper in Fig. 7 was developed to satisfy these four requirements. Much experimenting was done with quantity and position of brushes, design and temper of springs, and methods of operation. During the experimental runs several scrapers broke up in the line, but not one had to be cut out, and the pieces were always recovered. Most of these early failures were due to spring breakage and bristle loss; subsequent refinement of spring manufacture and use of brush holders eliminated these problems.

The amounts of solid deposits scraped from the pipe line by these tools far exceeded the amounts brought in by any previous device. The brushes, after the hundred-mile run, expanded to more than a 10-in. diam proving that they had contacted the pipe wall with positive pressure from beginning to end. The Neoprene cups, because of the supporting and centering effect of the spring-loaded brushes, wore equally on all sides. The effective cup life was increased from approximately 100 to 500 miles. It was immediately evident that an improvement had been made and that the intermediate traps were no longer an asset, but a liability. They have since been removed.

Following the successful use of this wear-compensating scraper in Plantation's 10 and 12-in. lines, a 4-in. scraper was built for the line to Montgomery from Helena, Alabama. Here it was found that a size limitation was encountered. After several variations were actually tried and many more proved impractical on paper, the lower limit of size was set at 6 in. This has since been found to be a desirable stopping point from the standpoint of relative economy as well as structural limitations.

In 1948 the Standard Oil Development Company initiated an application for patents on both the intermediate trap and the wear-compensating scraper and licensed T. D. Williamson, Inc., to manufacture and market the scraper. At this point new problems entered the picture. For instance, Plantation men who had worked with the original tools knew that the springs must be assembled at 90 deg, but other pipeliners could not be expected to exercise such care. Therefore, a simple clip was developed to hold the springs firmly in their proper position. In addition, safe traversal of a great variety of pipe lines had to be assured by slight changes in dimensions, which would provide positive support through any standard pipe line gate valves up to 600-lb API, or 800-lb WOG ratings. As mentioned before, holders were installed under the brushes to provide additional

FIGS. 6 to 19 on Page D-39. ➤➤

support and to prevent the bristles from pushing through the back of the hub. The body was changed to simplify assembly, provide for bypass action, and present a more solid nose structure to resist impact. This scraper, with the modifications shown in Fig. 8, is now manufactured in sizes 6-in. through 14-in. and is generally used in products lines. Some have been used as shown in natural gas lines as well, but their use is limited to those systems having no extremely sharp bends. The minimum safe radius of curvature varies from about 8 ft in the 6-in. size to 5 ft in the 14-in. size, due to small change in length throughout the range of sizes.

A variation of the scraper mentioned above, is the alternate assembly of the same pieces shown in Fig. 9. This assembly has the advantage of presenting a brushing action in advance of the first Neoprene cup and also provides a 10 to 15 per cent increase in flexibility. The initial brush is particularly desirable in crude oil lines where removal of soft paraffin can better be accomplished before it is "buttered" against the wall. For hard paraffin deposits or wax deposits with a high percentage of dirt or other solid particles, a stronger spring is generally recommended. An example of the result is shown in Fig. 9. Note that the brush segments have expanded upon removal from the trap to about 20 per cent greater than pipe diameter despite the fact that they are heavily loaded with paraffin. This would seem to prove that flat wire brushes are in reality a multiplicity of tiny blades and as such are perhaps more desirable than blades. Blades were tried on this scraper, as shown in Fig. 10, but when compared with brushes they have several disadvantages. First, they are heavier and therefore not only add to scraper weight and produce inequalities of top and bottom action, but also have greater lateral inertia and less shock resistance. They may knock more scale or hard carbon deposit from the pipe wall but have no real advantage in dirt or paraffin removal and certainly impart more wear and tear to the parts. For comparison, the 8-in. blade has 5 lineal inches of cutting edge (at a 45-deg angle) in contact with the pipe wall, whereas each 8-in. brush presents more than 25 in. of edge at 90 deg to the direction of travel. The knife type of cleaner has a total of less than 40 in. of cutting contact as compared with a total of more than 200 in. for the aforementioned brush-type scraper. For these reasons, the blade assembly is recommended only for those lines where a hammering action is needed to loosen heavy scale or carbon formations.

The application of the wear-compensating scraper to gas lines is more a problem of traversal than one of cleaning. The spring-mounted brush mechanism as used on this scraper has been found ideal for cleaning the smaller gas lines because of its positive pressure

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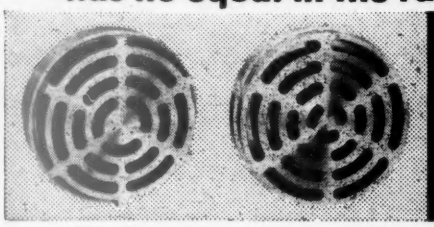

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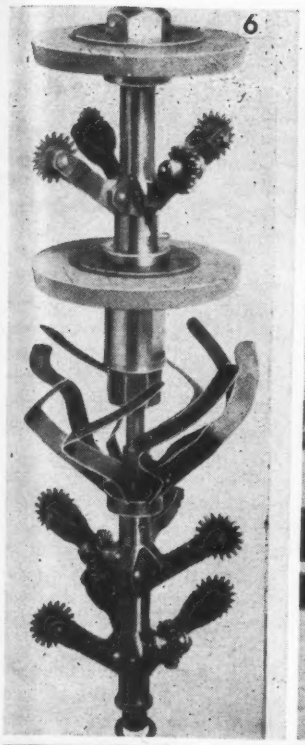
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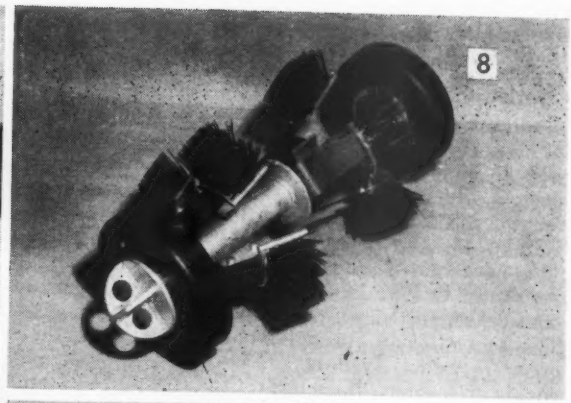
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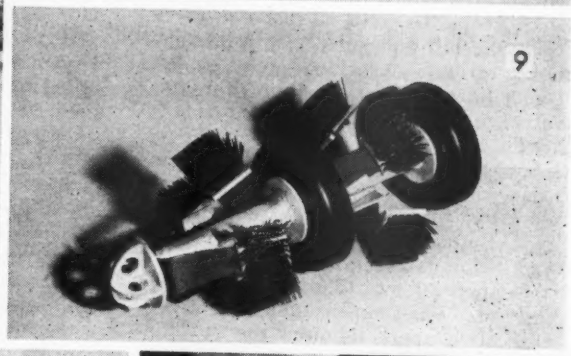
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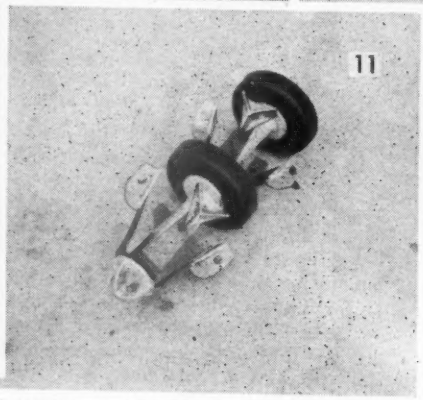
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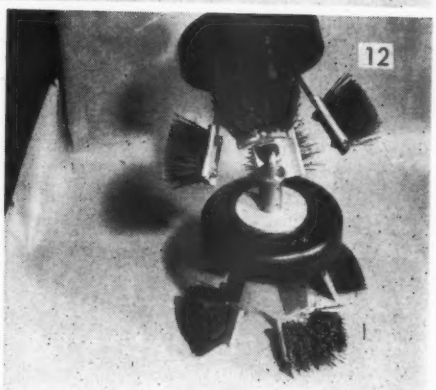
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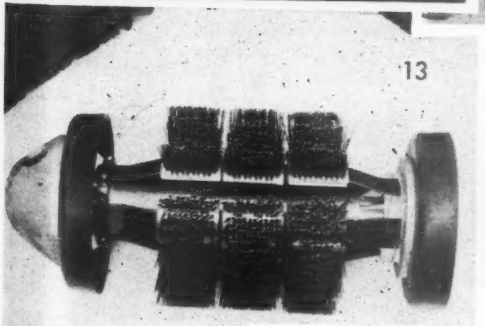
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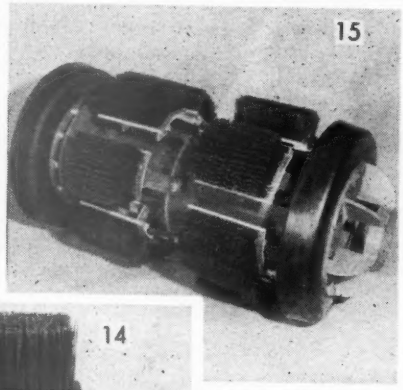
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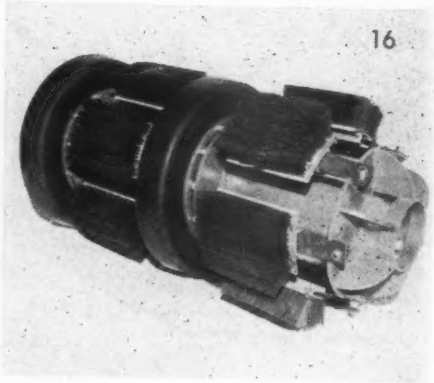
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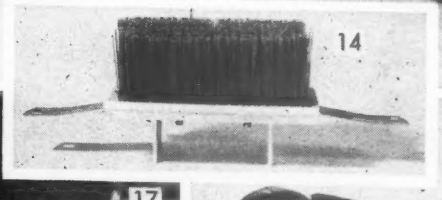
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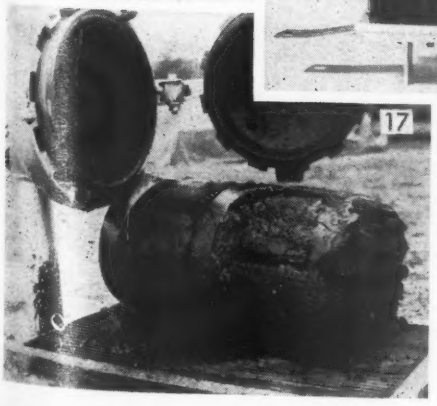
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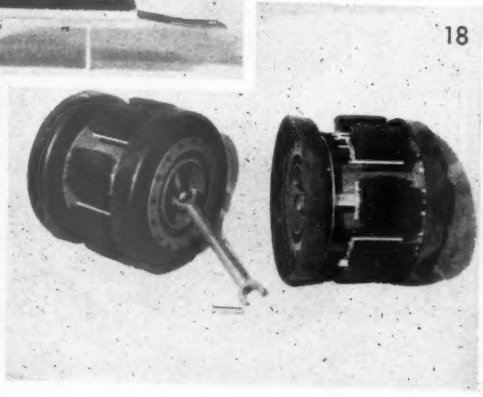
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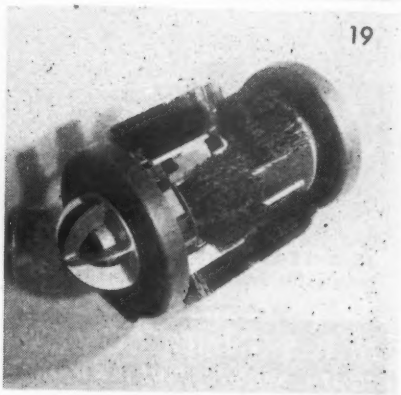
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against the wall, its compensation for the high rate of wear in relatively high speed runs through dry pipe, and its shock absorbing characteristics, which minimize the hammering effect that often bends and flattens the bristles of rigidly mounted brushes. But the basic design calls for a tool of considerable length, too long to traverse the sharp bends characteristic of many gas lines. This necessitated a design modification. As shown in Fig. 11, two half-scrapers may be connected with a jointed shaft. This tool will pass through welding ells of 1½ radius (radius of curvature equals 1½ pipe diameters), and the shaft keeps the units so disposed as to cover the full pipe surface with bristles. Other variations provide a spring loaded center-joint to assist in support through valves, or additional cups to provide a continuous seal past side openings. This is an example of the versatility of the basic parts and the advantage of a simple group of components with which to start. But it covers only that group of sizes below the "big-inch" range.

The first attempt to extend the advantage of wear-compensation to larger sizes of scrapers followed the obvious trend of simply making them bigger, but, as the 4-in. scrapers grew fragile from their size limitations, the larger scrapers suffered from the extreme forces present. Multiplications of smaller designs grew complex and heavy, or weak-kneed and inefficient. After several false starts and many experiments a new approach was considered. Engineers of the Products Pipe Line Department of the Phillips Petroleum Company had expanded the Plantation idea to increase the brush area. The scraper they developed, pictured in Fig. 13, had its brushes mounted on leaf springs with the front end of each spring securely mounted and the rear end sliding in a slot. It did not provide full pipe coverage in a single unit and did not have more than about ¾ in. expansive travel, but it did provide an increased bristle area, parallel wear of the brush and, most important of all, a good, solid and dependable mounting that could be adapted to larger sizes with only minor changes in dimensions and construction. This mounting was found to be well suited for scrapers for 16-in. and larger sizes. The brush and spring unit as shown in Fig. 14 is interchangeable for all sizes between 16-in. and 36-in. Naturally, the number of units disposed about the periphery of the scraper is varied with the size as is the location of the basic units as dictated by their function. For most large diameter products lines and some gas lines a scraper with two rows of brushes (staggered to provide full coverage as in Fig. 15) and a cup at each end is the best choice. A variation for crude oil lines has the first row of brushes in front of the cup, again to provide initial contact with paraffin.

This is, without doubt, the best tool ever developed for cleaning large diameter oil lines. Several of the larger lines began operating with enlarged versions of the bladed go-devil. Because of its long reputation, its curved knives still have a lot of respect in the oil industry. Unfortunately, this was another case of enlargement of the forces involved without possible comparable enlargement of the components and the failure of these go-devils caused operators to try the brush-type scraper even though they were convinced they needed a knife to do the job. The job of convincing operators that a flat wire brush is a multiplicity of blades is even harder in the larger sizes. To find out more about the comparable value of brushes and blades, tests are now being carried on in a large diameter oil line.

Actually the comparison here is more dramatic. The wear-compensating design of scraper in the 24-in. size as shown in Fig. 16 has more than 41,000 bristles and more than 215 lineal *feet* of cutting edge! The results are perhaps more startling. Many of these big-inch scrapers repeatedly make runs of 800 or 900 miles on one set of brushes and cups; runs of over 1000 miles are not unusual. When it is remembered that the savings of replacement parts (brushes and cups alone) for a 1000-mile run exceeds the price of the scraper, its value can be fully appreciated. Fig. 17 shows the type of results that can be expected. The brushes are packed with wax, but the bristle ends are still exposed and will continue to scrape the pipe wall for many miles. Experience in large diameter products lines has been limited to date. Although the wear characteristics have not been as good, because of the construction dirt present and limited lubrication value, it is evident that the wear-compensation scraper will outlast and out clean others in products as well as oil lines.

Most natural gas lines have been installed with welding ells and without on-stream cleaning facilities. The operation of scrapers was entirely ignored in the original construction and the only scrapers ever run through many of these systems were those that were used during construction. The work of the Panhandle Eastern and Texas Eastern lines has altered the thinking considerably. It has now been shown that on-stream cleaning is the economical way to maintain gas-line efficiency. Many of the lines now being planned or constructed are including facilities for scraper operation. Some lines are converting their entire systems to on-stream cleaning, but many older lines have conditions that defy the pipe line scraper. As a general purpose gas line tool, the big-inch wear-compensating scraper is arranged with one row of brush elements sandwiched between two cups. If full coverage of the pipe wall is required (actually about 60 per cent more than full coverage because each row covers approximately 80 per cent) two of the units are coupled with a jointed shaft as shown in Fig. 18. This scraper will traverse welding ells, full branch tees, through-conduit gate valves, and some models of conventional

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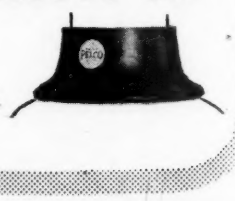

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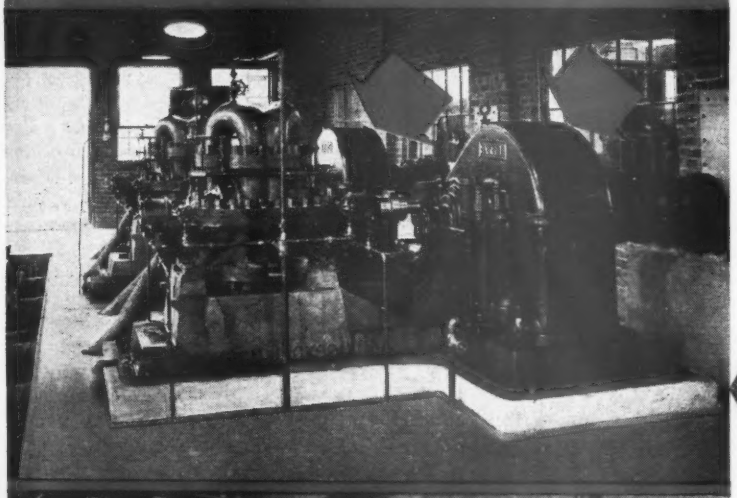

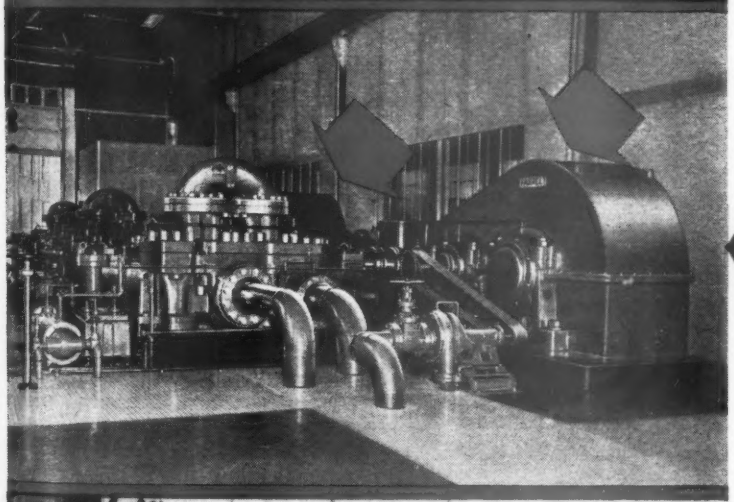

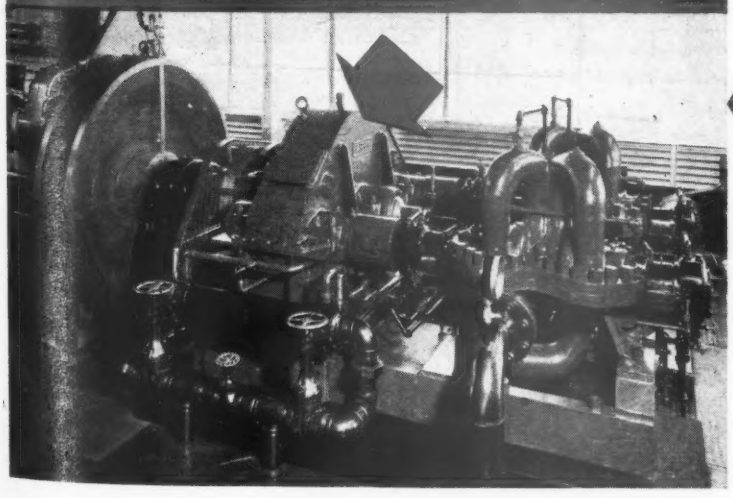

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gate valves. Changes in pipe wall thickness, reduced valve-port diameters, fittings with tapered walls and flat spots may slow this scraper down or stop it momentarily. Unlike the pressure-expanded or gas-bag type of cleaner, this scraper's brush action is entirely independent of inlet gas pressure. The increase in pressure that accompanies the retarded travel through a tight spot or a bend does not increase the spring-expanded brush friction with the pipe wall. The fact that this tool can pass the tight spots with a small pressure increase and no change of inlet valve setting is an evaluation of its flexibility, gas economy, and overall safety.

The use of scrapers in natural gas systems brought to light an additional application of the wear-compensation design. By using a double-spring mounting that approaches the full-elliptic rather than the original semi-elliptic design, the scraper can be made to clean effectively through a system containing pipe of two sizes. Special tools have been and are being made to clean 16-18, 20-22, 22-24, and 24-26 in. dual-size oil lines, water lines, and gas lines. These designs are also applicable to pipe lines having venturi, or reduced diameter, valves. In the smaller size a successful application has been found where one tool cleans a water line composed of bare and concrete lined 6 and 8-in. pipe. The inside diameter varies from 5⅝ to 8 in. Wear-compensating scrapers are provided for portable military pipe lines that have a 6.407 in. ID except for the short 6 1/16 in. ID ends. This doesn't seem important until it is considered that the old solid-brush tool would have been ineffective for more than 95 per cent of each joint of pipe. It must be remembered that these are special applications requiring individual considerations.

Although these examples are an indication of the flexibility that may be attained, they do not represent either the uses to which a standard scraper may be put or the limits of special designs. The standard wear-compensating scrapers have a range of flexibility that will allow them to pass safely through a circular section of reduced diameter (in straight pipe) equal to 90 per cent of schedule 40 pipe ID in the 14 in. and smaller sizes and equal to a diametric reduction below standard pipe (⅜-in. wall) of 1¼ in. in larger sizes. Comparable spot reductions at flat spots, dents, and valve seat rings can also be traversed, but long runs through pipe heavier than ½-in. wall should not be attempted without modifications to the brush mountings and cups.

The most recent developments in the line of wear-compensating scrapers are aimed at increases in flexibility and brush coverage. As mentioned previously, one method of achieving both flexibility and full coverage is through the use of either a jointed body or a connecting link between short units. Another approach is to use a single short element with the overlapping Z-shaped brushes shown in Fig. 19. This design appears to be particularly adaptable to the range of sizes between 10 and 20 in. It offers a maximum of brush area for a minimum of weight and is easier to service and install than the jointed models.

This is by no means the end. There is in constant operation a program of investigation and analysis aimed at the improvement of present models. Considerable work is being done to adapt and modify standard tools to meet special conditions. Perhaps of most importance, a new program of research and development has been created to probe into the requirements of the future—these requirements include scrapers to pass through plug valves, cleaners that will indicate their location, and tools to do other jobs inside the pipe line.

Acknowledgment

The author wishes to thank the Plantation Pipe Line Company for providing the initial impetus and proving ground for this project. Appreciation is extended also to the many pipe line companies who have aided the progress of this program by their continued use, welcome criticism, and suggestions for improvement of the wear-compensation scraper.

* * *

☆ ☆ ☆

Although the U. S. has only 12 per cent of the world's land area geologically favorable for petroleum, American oil men have discovered about 66 per cent of all the oil found in the world to date.

THE PIG WITH THE POKE — CLEANS PIPE LINES

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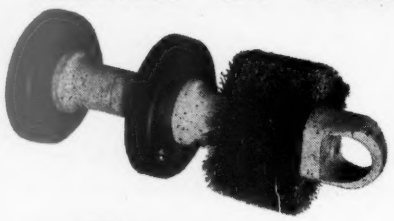
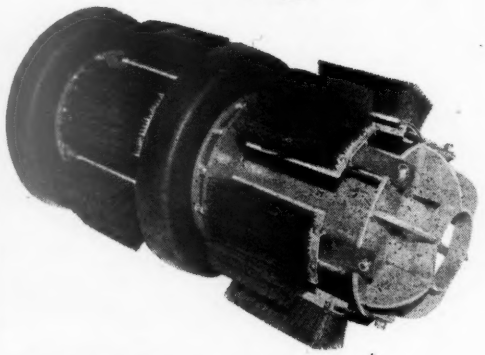


Type JR Pig 2" to 5" sizes. Economical and Rugged.

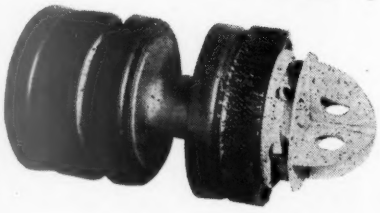


Type GP-4 Pig 16" to 30" sizes.

Similar design for 10" to 14" sizes.

Brushes expanded by arched springs.

Brush and cup service life up to 1,000 miles.



Type RC-50 Pig 8" to 14" sizes.

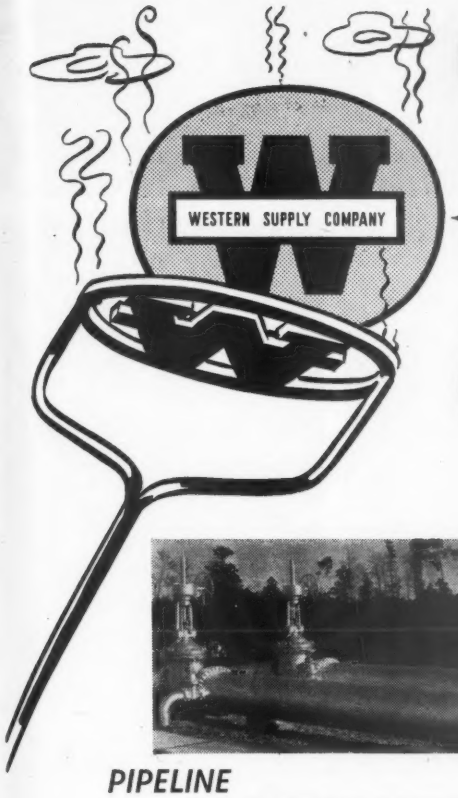
6" size, similar, type SC-50.

Jet-rotation feature distributes wear of brushes and cups.

REPRESENTATIVES

H. E. Davis, Los Angeles 15, Calif.
James S. Kone Co., Amarillo, Texas
Keyes Tank Co., Provo, Utah
Keyes Tank & Supply Co., Casper, Wyoming
Canadian Equipment Sales & Service Co., Ltd., Edmonton, Calgary, Toronto, Canada

T. D. Williamson, Inc.
TULSA 9, OKLAHOMA



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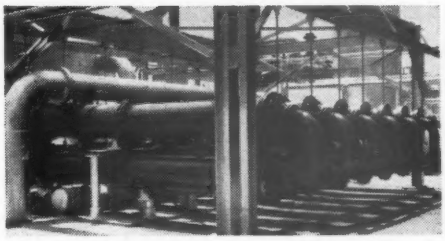
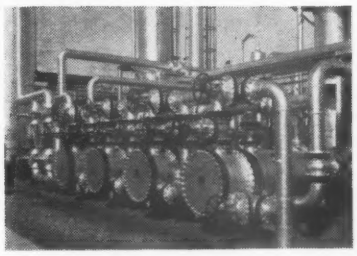
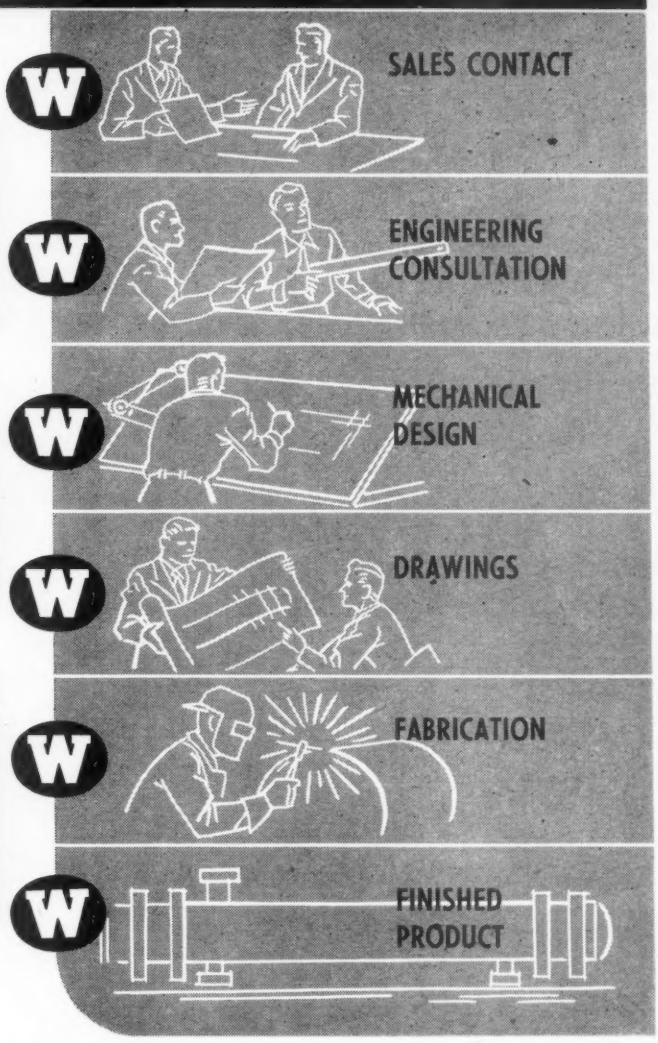
PIPELINE



PETROCHEMICAL



REFINING & NATURAL GASOLINE



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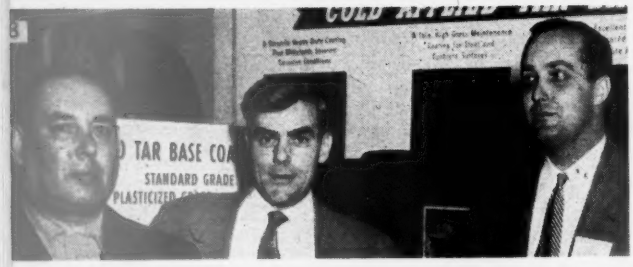
STANDARD GRADE

PICTORIAL

NACE, Galveston Meeting

1. Jack O'Brien and John G. Bolling, Tapecoat Company.
2. Bennie Means, Pittsburgh Coke and Chemical Company; Dean Glass, Pure Oil Company; Boyd Mayes, Mayes Brothers; Lloyd Daugherty, Mayes Brothers; Steve Day, S. D. Day Company.
3. Mike Nelson and E. J. Brecht, Cities Service Pipe Line Co.
4. Mrs. R. G. Roberts; Gaines Laster, Tulsa Pipe Coating Company; R. G. Roberts (standing), The Barrett Division.
5. R. L. Renshaw, Reilly Tar and Chemical Company, and Jack Callaway, M. J. Crose Manufacturing Company.
6. Vernon E. Percele, The Gas Service Company; J. F. Fugazzi, Public Service Company of Colorado; Dick Renshaw, Reilly Tar and Chemical Company; Ray Wiseman, Colorado-Wyoming Gas Company; Norman Locke, E. E. Rouland, Mrs. Malcolm Mitchell, and J. D. Keith, all of Reilly Tar and Chemical.
7. C. D. Cobbett and Bob McCarthy, Hill, Hubbell and Company.
8. E. H. Snashall, The Ohio Fuel Gas Company; Art Gray and O. E. McCullough, Jr., Pittsburgh Coke and Chemical Company.
9. J. P. Cummins and Bert A. Espiau, Centriline Corporation.
10. W. Mitchell, Ethyl Corporation, and H. H. Frasch, National Carbon Company.
11. Paul B. Payne, Wayne H. Schultz, and Marty Share, Dearborn Chemical Company.
12. L. G. Moore, The Texas Company; Robert F. Frank, Walter L. Jones, C. W. Montgomery, and D. L. Korn, all of The Natasco Company.
13. Bo Bardsley, Crutcher-Rolfs-Cummings; Harry K. Phipps, Socony-Vacuum Oil Company; Herbert E. Fisher, C-R-C Engineering; G. H. Osborn, Crutcher-Rolfs-Cummings.
14. Yale W. Titterington, Standard Magnesium Corporation; Ray Trapp, Midwestern Engine and Equipment Company; R. M. Wheeler, Standard Magnesium.

15. James H. McBrien, T. D. Williamson, Inc.; T. D. Williamson, Sr.; P. D. Phillips, Jr., Humble Pipe Line Company; T. D. Williamson, Jr.
16. Charles Oakley and G. Stannard Owens, National Lead Company.
17. Paul H. Risk, W. B. Evans, and Paul J. Moore, Philip Carey Manufacturing Company.
18. Fred Daniels, R. T. Browning, and Glenn H. Frizzell, Electro Rust-Proofing Corporation.
19. O. C. Roddy, Interstate Natural Gas Company; Gus Vogler, Wayne Broyles, Earl Owens, and K. B. Shearon, all of Brance-Krachy Company.
20. Leonard C. Hill, Kansas-Nebraska Gas Company; Bill Watson, Standard Pipeprotection, Inc.; L. C. Secrest, Continental Pipe Line Company, F. M. Cummins, Standard Pipeprotection.

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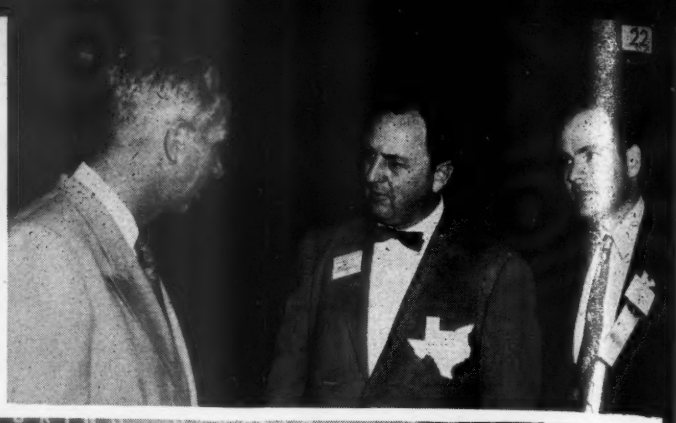
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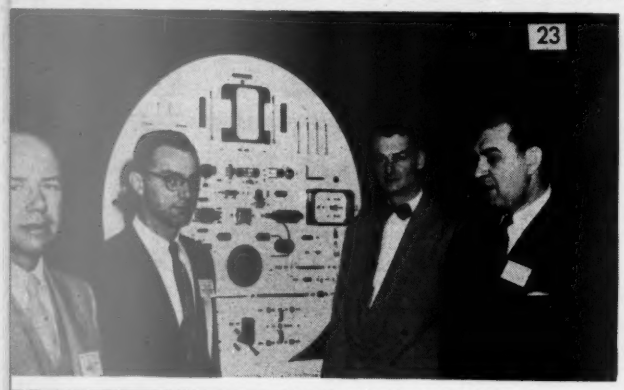
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21. R. D. de Laski and N. T. Shideler, Pittsburgh Coke and Chemical Company; Derk Holsteyn, Shell Oil Company.
22. Ned Stearns, Holcombe and Stearns; Murray Crawford, Aluminum Company of America, and J. F. Williamson, Jr., Southern Signals, Inc.
23. Dick Stearns, Maurice Belsen, and R. H. Lee, of D. E. Stearns Company; T. S. Zajac, Shell Oil Company.
24. James Klein, Texas Gas Transmission Corporation; Thomas Brady, Western Kentucky Gas Company; R. W. McIntosh, Dresser Manufacturing Division, Dresser Industries, Inc.; Fred D. Stull, Texas Gas; Paul F. Marx, Elton E. Peavy, and H. Z. Hight, all of Dresser
25. Tom Holcombe, Holcombe & Stearns; Herschel J. Wood, Lebanon Steel Foundry, and Al Stegner, Tennessee Gas Transmission Company.
26. W. L. Mabrey, Gulf Refining Company; Earl V. Dragics, Owens-Corning Fiberglas Corporation; Jim Neal, Owens-Corning; Jack Bost, Midwestern Engine and Equipment Company; Ted Murrey, Midwestern Engine and Equipment; Sam Bosley and W. H. Sedgeman both of Owens-Corning Fiberglas.
27. Virgil Fichter, Midwestern Engine and Equipment; Bill Armour, Standard Pipeprotection; H. E. Burtner, Midwestern Engine and Equipment; Marie Harrison; Brownie Bronkow, Tulsa Pipe Coating, Inc.; Dick Stearns, D. E. Stearns Company; E. W. Robinson, M. J. Crose Manufacturing Company.
28. O. E. McCullough, Jr., Pittsburgh Coke and Chemical, and Brownie Bronkow, Tulsa Pipe Coating, Inc.
29. R. C. Kenan, Otto Wheeley, and Julius M. Kamps, of Koppers Company, Inc.; Billie Barrineau (Miss Bitumastic), and Jim Gibbons, Koppers.
30. O. C. Mudd, Shell Pipe Line Company; Wm. S. Stokes, Pipeline Coating and Engineering Company; Robert H. Kerr, Southern California Gas Company.
31. Vance C. Jenkins, Union Oil Company, and Milton Bowen, Hill, Hubbell and Company.
32. E. L. "Jack" Henry, Crutcher-Rolfs-Cummings, and J. H. Conroy, Barrett Division, Allied Chemical and Dye Corporation.
33. Morley Lewis, Perrault Brothers; Don R. Patterson, Atlantic Refining Company, and John M. Harvey, Perrault Brothers.

United Gas Given Permit for Short Line

The Federal Power Commission has authorized United Gas Pipe Line Company, of Shreveport, Louisiana, to construct an 11.3-mile pipe line in Terrebonne Parish, Louisiana, to obtain natural gas from two additional gas fields.

The proposed 20-in. line, estimated to cost $1,461,000, will connect with the company's system in Terrebonne Parish and extend southwest to the Turtle Bayou and Kent Bayou gas fields. Capacity of the line will be 143,000,000 cu ft of natural gas a day.

NEWS

IPC's 30-In. Pipe Line To Be Completed in April

Completion of the Iraq Petroleum Company's new 560 miles 30-in. pipe line from Kirkuk to the Mediterranean is announced for April this year—six months ahead of schedule. Anglo-Iranian has a 23¾ per cent holding in the IPC group.

The new pipe line, the largest connecting Iraq oil with the seaboard, will carry 280,000 bbl of crude oil a day from Kirkuk to Banias, Syria, where a terminal has been specially built on the coast.

Owing to world shortages of steel and equipment, construction of the new pipe line, which was planned five years ago, could not begin until September, 1950. Its completion well ahead of schedule makes a further contrast with the oil-exporting standstill in neighboring Iran.

Natural Gas Companies' Operating Revenues, Income

Operating revenues of natural gas companies reporting to the Federal Power Commission totaled $170,899,456 in December of 1951, an increase of 10.3 per cent over December, 1950, receipts of $154,951,856. For the 12 months ended December 31, 1951, revenues aggregated $1,557,073,468 or 18.7 per cent higher than the $1,311,585,960 received in the 12 months ended December 31, 1950.

Gas utility operating income for December, 1951, amounted to $29,700,271, up 15.1 per cent from the $25,809,054 reported for December of last year. For the 12 months ending with December, 1951, gas utility operating income was $232,956,747, representing an increase of 8 per cent over the $215,727,721 reported for the comparable period ending in December, 1950.

Net gas utility plant of the reporting companies aggregated $3,791,573,445 on December 31, 1951, up $625,893,191, or 19.8 per cent over the $3,165,680,254 reported a year ago.

Gas operating revenue deductions during December, 1951, amounted to $141,350,910, an increase of 9.5 per cent. Of this total, operating expenses accounted for $109,257,692; depreciation for $12,122,955, and taxes for $19,970,263.

Gas sales to ultimate consumers during the month were 223,961,000,000 cu ft, an increase of 6.9 per cent over December, 1950.

Sales to residential and commercial consumers increased 8.1 per cent and 5.5 per cent, respectively, while those to industrial consumers increased 4.1 per cent. Revenues from sales to ultimate consumers increased 8.3 per cent and amounted to $82,963,827. Revenues from the three classes of service—residential, commercial, and industrial—increased 8.4 per cent, 8.2 per cent, and 5.9 per cent, respectively.

Net income of the companies for December, 1951, was $26,517,925, up 19.4 per cent from the December, 1950, net of $22,202,009. For the 12 months ended December, 1951, net income of $183,922,891 represented an increase of 2.6 per cent over the $179,295,676 realized in the comparable period ended December, 1950.

Fairlie Tells Importance Trans-Mountain Pipe Line

Completion of the Trans Mountain pipe line will bring British Columbia an assured supply of oil, will lead to expansion and modernization of Vancouver refineries, and may encourage new industries, possibly petrochemicals, John Fairlie of Toronto told a joint meeting of the Chamber of Commerce and Rotary Club recently at Victoria. Fairlie is manager of the co-ordination and economics department of Imperial Oil, Ltd.

Fairlie stressed the importance to British Columbia of a direct connection with the prairie oil fields. This province, he said, has the highest per capita consumption of oil in Canada, 60 per cent above the national level. "This year over 600 gallons of petroleum will be used by each one of you," he said, forecasting even larger consumption in the future. With a pipe line, British Columbia will not have to depend for crude supplies on tanker shipments, which can be affected by international tension.

Construction of the 700-mile line from Edmonton to Vancouver begins next month. When the line goes into operation in 1954, it will deliver only enough oil to meet the immediate British Columbia demand. It will lay down the oil in Vancouver at the same price as imported crude from California, and there will be no immediate effect on product prices.

"If the pipe line throughput were increased from the initially planned operation of 37,500 bbl a day to say 150,000 the pipe line charges (of 60 cents a bbl) would be cut roughly in half," Fairlie predicted. If that happens, he went on, Canadian oil could overcome the duty of up to 21 cents a bbl that the U. S. now imposes on crude oil and be cheaper than other supplies in markets such as Seattle. If other factors affecting the price of crude remained constant, this would result in a lower crude price at Vancouver, which would be reflected in the price of finished products.

Some idea of the immensity of the $80,000,000 pipe line was given by Fairlie. "It would take 13 days at the present rate of production for all the wells in the prairies to fill the line," he said: "That would be enough oil to keep the refineries in British Columbia operating at today's capacity for almost 2½ months."

Trans-Northern Offices Moved

Trans-Northern Pipe Line Company has moved its offices from Room 1011, 25 Adelaide St. E., Toronto, Ontario, Canada, to the Hermant Building, 21 West Dundas Square, Toronto.

Financing Arranged for Texas Gas Expansion

Texas Gas Transmission Corporation announces that it has completed arrangements for financing its proposed 400-mile, 26-in. natural gas pipe line project. The pipe line planned for 1952 construction, is designed to move more natural gas from the Southwest to Mid-Western and Appalachian markets.

W. M. Elmer, vice president and treasurer, announced that his company has commitments from 14 institutional investors to purchase $24,000,000 of first mortgage 4 per cent bonds at 98 upon approval of the company's expansion program by the Federal Power Commission. The FPC is now holding hearings on the company's project.

Elmer said that earlier these investors purchased $13,000,000 of the bonds at the same price. He added that the bond sale together with earnings and depreciation money accumulated during the year will be adequate to complete the construction program.

The 400-mile line will be built in six sections from Bastrop, Louisiana, to Louisville, Kentucky, along the path of the existing Texas gas system. The company expects to complete the project by November, thus raising daily delivery capacity by 240,000,000 cu ft to a total of approximately 950,000,000 cu ft a day. Texas gas delivers gas to distributing utilities in Louisiana, Arkansas, Tennessee, Kentucky, Indiana, Illinois, and Ohio, and the Appalachian areas.

Texas Gas reports that steel pipe and other critical materials required for the project have been allocated by the Petroleum Administration for Defense and are on firm order. Initial steel deliveries are expected to begin in June.

L. H. True

Don R. Ford

A. T. Glover

L. H. True Made President Magnolia Pipe Line Company

At the annual meeting of the board of directors of Magnolia Pipe Line Company held in Dallas, March 11, Leslie H. True was elected president of the company, it was announced by J. L. Latimer who has been president. Latimer has been elevated to chairman of the board.

It was also announced that Don R. Ford, assistant manager of pipe lines and board member, was elected vice president of Magnolia Pipe Line Company and that A. T. Glover, general superintendent, was made a director.

L. H. True, who has been with the Magnolia organization for nearly 30 years, has served the company's vast pipe line system as pipeliner, time keeper, gager, pipe line scout, and as a district superintendent before being transferred to Magnolia's general offices in Dallas 15 years ago. True was made a vice president in October 1945, and on January 1, 1946, was made manager of pipe lines.

Don R. Ford has been with Magnolia Pipe Line Company for nearly 25 years, during which time he has been pipeliner, district gager, chief gager, and has held various supervisory positions in many areas served by the company's pipe line network. In August, 1949, he was transferred to Dallas to be assistant manager of pipe lines from division superintendent of the company's southern division at Houston. Ford was made a member of Magnolia Pipe Line Company's board of directors a year ago.

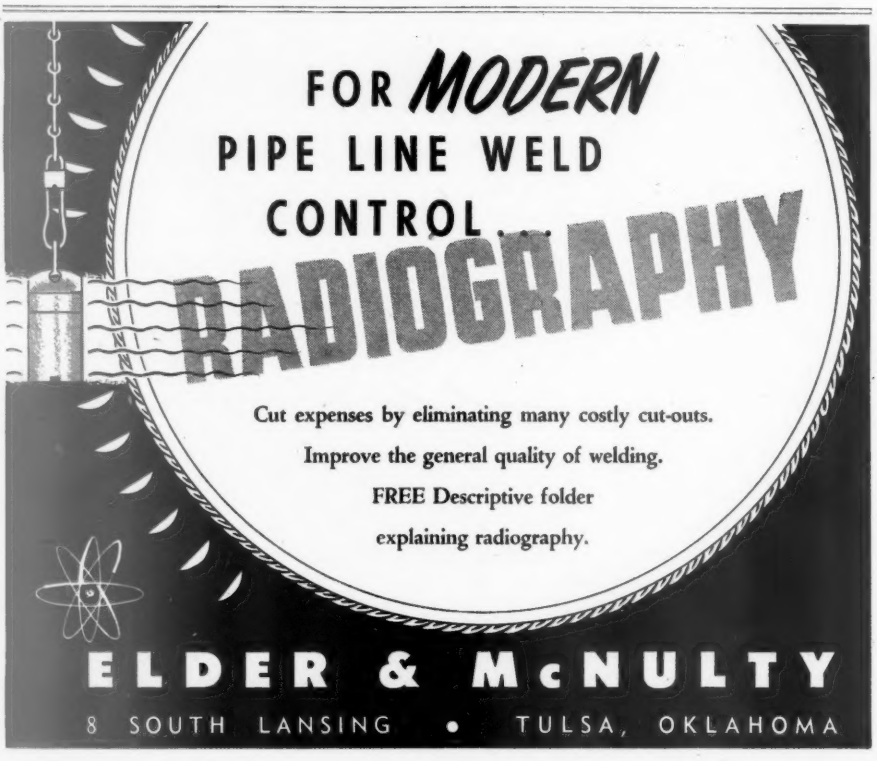
A. T. Glover has been general superintendent of the pipe line company for 10 years. During his early service with the company he assisted in the construction of some of the first pump stations of Magnolia's pipe line system. After serving as construction foreman at various places in Texas he was moved to Oklahoma where he later became district superintendent at Wewoka and then superintendent of the Oklahoma division with headquarters at Oklahoma City. Glover was transferred to the company's general offices in Dallas in 1942 and promoted to general superintendent.

API Publishes Revised Pipe Line Metering Code

The American Petroleum Institute has announced the publication of a revision of its "Tentative Code Covering Installation, Proving and Operation of Positive Displacement Meters in Liquid Hydrocarbon Service" first issued in July, 1946, and identified as API Code No. 1101. The 1946 issue and the current revision are the work of the Subcommittee for Joint ASME-API Volumeter Research of which L. S. Wrightsman, Humble Pipe Line Company, Houston, Texas, is chairman.

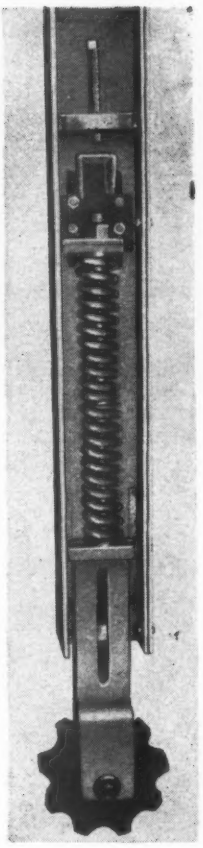
The code covers metering in pipe line service, on tank trucks, and at loading racks and bulk plants. In addition, the new edition contains sections on meters in liquefied petroleum gas products service and in oil well production service. The code includes charts and diagrams.

The revision is the product of more than 10 years work by the joint ASME-API committee. More than five years were spent in preparing the 1946 edition and since 1946 the committee has given careful study to all suggestions that have been offered for improvement. The revision is believed to represent a solution of most of the problems which have arisen from actual use of the code. Copies may be obtained at $2.00 a copy from J. A. McNally, The American Petroleum Institute, 50 West 50th Street, New York 20, New York.



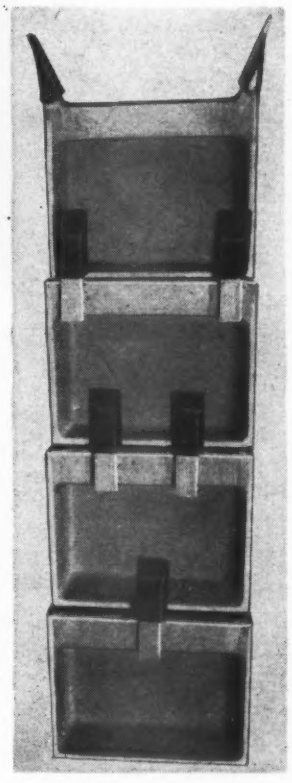
2 New Features Increase Output of Longhorn Ditcher

1. Spring loaded boom handles rock and stone--absorbs shock



By spring loading the boom of the Longhorn Mobile Ditcher it is now possible to dig much harder material at a faster rate and at the same time minimize the hazard of hidden obstacles. This new boom absorbs practically all of the shock load and enables the Longhorn to handle rock and stone up to 5 inches in diameter.

2. H & L Teeth stay sharp--are quickly renewed



With the bucket line equipped with H & L Removable and Replaceable Teeth the production output of the Longhorn is greatly increased. These tough alloy steel teeth, which are so widely used in dirt moving equipment, remain sharp at all times. Replacement time is reduced to 20% of the previous time for renewing cutting edges and replacement costs are reduced by 50%.

LONGHORN INDUSTRIES, INC.

Phone 4535 **P. O. Box 350**

Henderson, Texas

These new improvements are two more reasons we say, "When you invest in a Longhorn, you buy lower ditching costs." If you require small ditching equipment, it will pay you to look at a Longhorn Mobile Ditcher with its many exclusive features. We will be glad to arrange an actual demonstration. Just write, wire, or phone.

Corrosion Short Course Draws Excellent Attendance

The third annual corrosion short course sponsored by the Tulsa Section of the National Association of Corrosion Engineers drew an attendance of 190 this year at the late February meeting, a number of participating companies sending from 9 to 13 men each. As was the case last year, Canadian companies also were represented.

The short course is conducted on a non-technical basis primarily for the purpose of bringing to field foremen, superintendents, engineers, and inspectors the basic principles of corrosion and methods for its control.

One innovation this year was the manner in which the field trip was handled. Prior to the meeting, an 80-ft length of coated pipe and an 80-ft length of bare pipe were buried in the Arena Building at the Tulsa Fair Grounds. The field demonstration was held at this location with all field tests run on these short lengths of buried pipe. Bleacher seats were set up alongside the test section for the convenience of the observers. The inspection trip, held the last afternoon, was a conducted tour through the plants of the Standard Magnesium Corporation, Tulsa Pipe Coating Yard, and The Allied Paint Company.

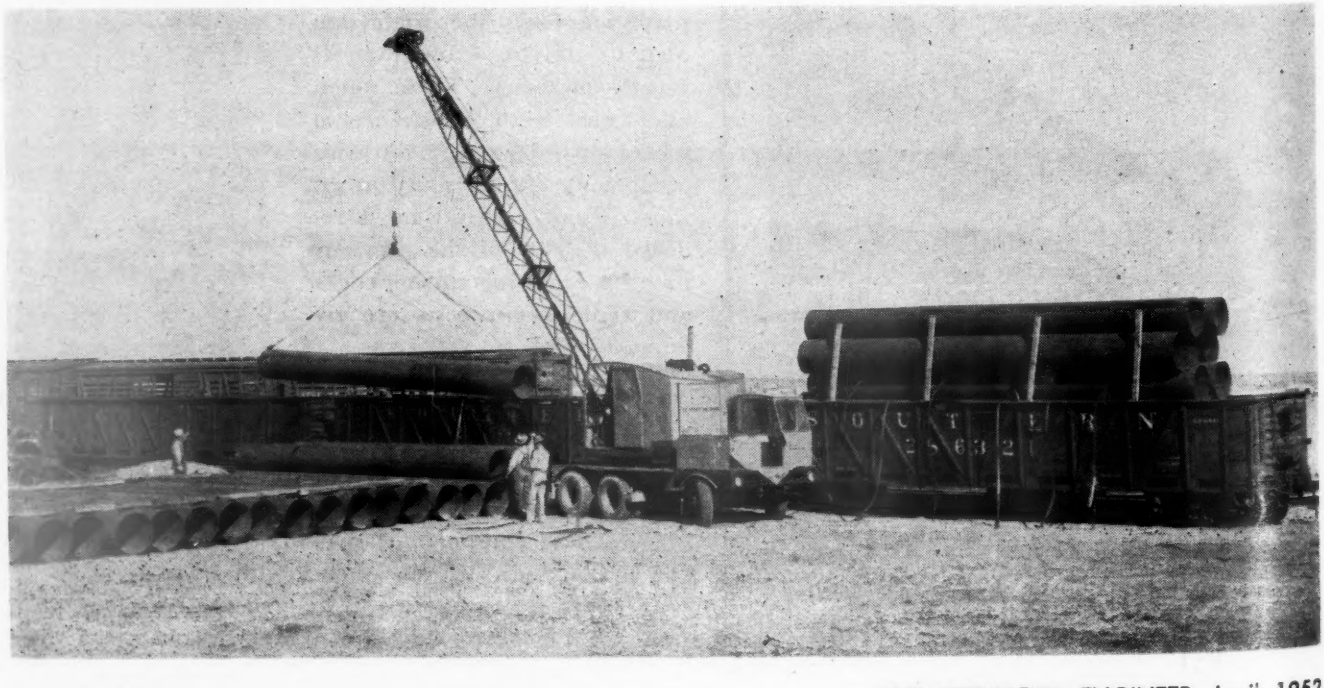
Instruction and field work were by J. R. Cowles of the Oklahoma Natural Gas Company, and W. E. Huddleston of the Huddleston Engineering Company. Assisting in the field work were Hugh A. Brady of Pipeline Maintenance Corporation and H. M. Hughes of Oklahoma Natural Gas Company.

The planning committee was composed of J. R. Cowles; F. M. Cloninger, The Texas Pipe Line Company; O. E. Murrey, Midwestern Engine and Equipment Company; H. M. Hughes; Sam E. Bosley, Owens-Corning Fiberglas Corporation; Hugh A. Brady; and Y. W. Titterington, Standard Magnesium.

Williamson representatives attend short course. W. E. Huddleston, consulting engineer who was instructor for the third annual NACE Short Course in Tulsa on February 27-29, is shown demonstrating road-casing test to T. D. Williamson, Inc., representatives (l. to r.) Norman Williams, Provo, Utah; Floyd Zongker, field engineer; Linden Stuart, Jr., Keniworth, New Jersey; T. D. Williamson, president; Harold Davis, Los Angeles; James Kone, Amarillo, Texas; Dale Hardy, Provo, Utah; T. D. Williamson, Jr., vice president, and Huddleston.

Rubber-tire cranes on stringing job. This pipe unloading job at Carlsbad, New Mexico, handled by Dunn Bros., Dallas, Texas, for the El Paso Natural Gas Company is typical of the increased use of rubber-tire cranes by pipe stringing contractors. This Lorain 15-ton Moto-Crane is shown handling 31-ft long 30-in. diameter pipe for a 10-4/10 miles long gas line loop. Up to 50 cars are unloaded in a 10-hr shift. Rubber tire units such as this have the highway speed to travel quickly where needed, also the rough ground travel ability to follow pipe line right-of-ways. For example, this Moto-Crane travelled the 467 miles from Farmington, New Mexico, to Carlsbad in 21½ hr travelling time, over icy roads.

This speed of movement contributes materially to the fast pace necessary in pipe stringing operations.



Dr. Mars G. Fontana New President NACE

Dr. Mars G. Fontana, professor of metallurgy at Ohio State University, was elected president of the National Association of Corrosion Engineers, which held its annual meeting in Galveston, Texas, March 10 through 14. He succeeds N. E. Berry of Servel, Inc., Evansville, Indiana.

Chosen to serve with Dr. Fontana were Walter F. Rogers of the Gulf Oil Corporation, Houston, Texas, who is the new vice president, and Russell A. Brannon of the Humble Pipe Line Company, re-elected treasurer for the third time.

Four new directors were named to the board of 20 members. They are: Hugh P. Godard, Aluminum Laboratories, Ltd., Kingston, Ontario, Canada; V. V. Kendall, National Tube Division, United States Steel Company, Pittsburgh, Pennsylvania; Norman Hackerman, professor of chemistry, University of Texas, Austin, and L. L. Whiteneck, Long Beach Harbor Department, Long Beach, California.

The 1952 NACE Awards were presented to Starr Thayer, consulting corrosion engineer of Houston, Texas, and Earl A. Gulbransen, advisory engineer to Westinghouse Research Laboratories in East Pittsburgh, Pennsylvania. Thayer received the Frank Newman Speller Award for achievement in the field of corrosion engineering. To Gulbransen went the Willis Rodney Whitney Award for achievement in the field of corrosion science.

The number registered at this year's meeting, which was 1368, set an all-time record. Thirty-three technical papers were delivered and in addition there were two round table discussion sessions, one on pipe line and underground corrosion and the other on general corrosion. There were 82 exhibits.

Chicago, Illinois, was selected for the 1953 meeting.

Pictures in addition to the accompanying will be found on pages D-44, D-45, and D-46.

Motorola Expands Carrier And Control Systems Group

Motorola's carrier and control systems engineering department, formerly a part of the carrier and control development engineering department, has been expanded as a result of the rapidly growing increase in carrier, telemetering, and control systems engineering and sales activity. Leonard Walker has been appointed as chief systems engineer.

Duties of the department include analyzing and designing individual systems to meet customers' requirements whether it be for power line carrier or other control equipment for power utilities, pipe lines, railroads, or other industries. The activities will continue to parallel those of the carrier and control development engineering department under the direction of John Doremus, chief engineer.

Leonard Walker came to Motorola in July, 1951, from the Idaho Power Company where he was in charge of communications.

This is the third systems engineering group in the communications and electronics division. The others design and produce 2-way mobile radio networks and microwave radio relay systems.

FPC Approves Leasing Pipe Line When Built

The Federal Power Commission has authorized Mississippi Gas Company, of Meridian, Mississippi, to lease and operate natural gas transmission facilities in Mississippi to be owned and contructed by the North Central Natural Gas District, a political sub-division of the State of Mississippi.

The facilities include a 99-mile pipe line extending from a point on Southern Natural Gas Company's main line in Winston County, Mississippi, to the town of Bruce in Calhoun County, Mississippi. Mississippi Gas Company also will operate lease lateral lines and facilities for the distribution of natural gas in 12 communities comprising the North Central Natural Gas District.

Under the lease agreement between the company and the District, the rent payable to the District will be sufficient to pay service charges, including interest and amortization of principal on the bonds issued by the District for construction of the facilities.

Promotions by Pittsburgh Coke and Chemical

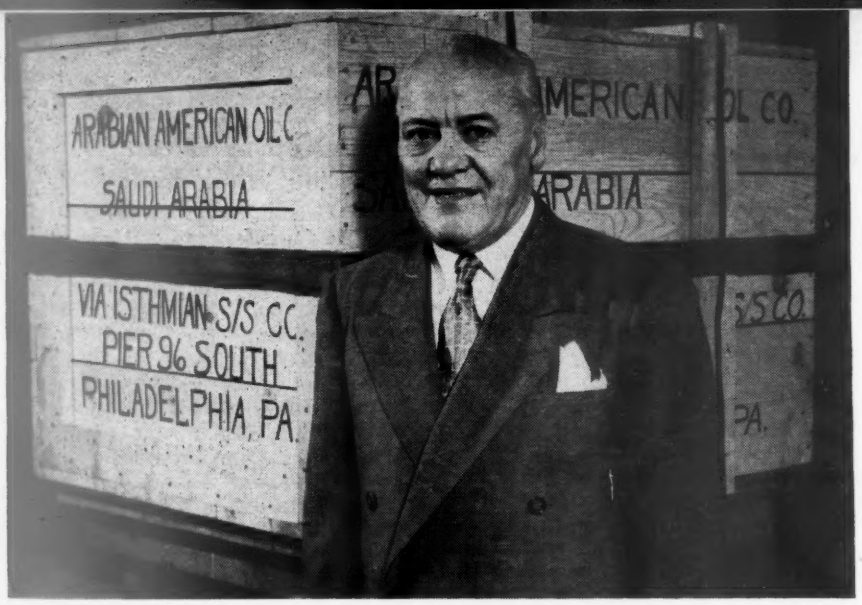
O. E. McCullough, Jr., has been promoted to manager of the Protective Coatings Division of the Pittsburgh Coke and Chemical Company, Pittsburgh, Pennsylvania. He has been manager of the Tar Base Coatings Division.

Art Gray has been made assistant manager in charge of tar base coatings and Howard Trusler assistant manager in charge of synthetic coatings.

It is also announced that E. W. "Red" Lawlor is now in charge of the Tulsa, Oklahoma, sales office of the company.

A. B. Campbell, executive secretary of NACE; Walter F. Rogers, new vice president; N. E. Berry, retiring president; Russell A. Brannon, treasurer for the third time, and Dr. Mars G. Fontana, the new president.

Three of the new directors and the retiring president: V. V. Kendall, L. L. Whiteneck, N. E. Berry, and Hugh P. Godard.



William J. Williams, president of Synchro-Start Products, Inc. (Skokie, Illinois) at factory dock to witness shipment of the 500,000th automatic engine control set.

Automatic Engine Controls

The talk of another war and air-raid bombing has created an overwhelming demand for automatic engine controls in the oil industry, according to W. J. Williams, president of Synchro-Start Products, Inc. Announcing the shipment of the company's 500,000th automatic control set, Williams pointed out that automatic engine controls to insure emergency power are now used extensively by pipe lines all over the country.

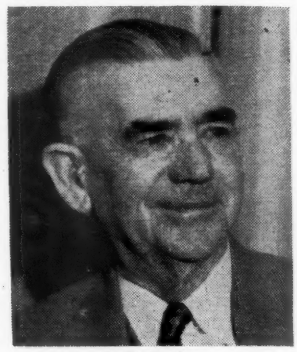
The 500,000th control set to be produced by Synchro-Start, was shipped (as one of eight sets) to the Arabian-American Oil Company in Arabia to assure that if the oil pipe line's normal power source is damaged, emergency power would be turned on automatically to meet the basic power needs of the pipe line. The controls will be installed on Tapline, the abbreviated name used for Trans-Arabian Pipe Line Company's oil pipe line system that connects the oil fields of eastern Saudi Arabia with the Mediterranean shipping terminal at Sidon in the Republic of Lebanon.

"Of late," said Williams, "it is interesting to notice that the oil industry has been installing these automatic engine controls against the possibility of power failure through acts of war. In case of failure of the utility lines for any reason, Synchro-Start controls will immediately start the engine driven generator to take over the load and keep oil wells pumping, etc., until the power is restored.

Automatic controls on pipe lines and storage tank pumping engines, Williams pointed out, are installed to keep the oil flowing at all times according to requirements. Actuated through float or pressure switches, the engines automatically start and stop as demanded, with no running of engines unnecessarily after the tank is empty.

J. R. Doles Retires From Ajax Pipe Line

J. R. Doles, vice president and general manager of the Ajax Pipe Line Corporation, Springfield, Missouri, was guest of honor at a banquet in the Colonial Hotel in Springfield on Thursday evening, March 6. On April 1 he formally retired, climaxing a career of



J. R. Doles

more than 42 years. Employees of the Ajax Pipe Line Corporation, personal friends, members of his family, officials of Interstate Oil Pipe Line Company, and many prominent members of oil and pipe line industries were present at the banquet.

Among the out of town guests were W. A. McAfee, president, Ajax Pipe Line Corporation, Cleveland, Ohio; W. R. Finney, pipe line advisor, Standard Oil Company (New Jersey), New York City; Loren F. Kahle, deputy coordinator of transportation activities of Jersey Standard, New York City; K. A. Covell, vice president Pure Oil Company, Chicago, Illinois; O. M. Jaco, superintendent, The Ohio Oil Company, Pipe Line Division, Martinsville, Illinois; O. Q. Lomax, president, Humble Pipe Line Company, Houston, Texas; O. C. Schorp, president and J. W. Brice, chairman, The Carter Oil Company, Tulsa; and J. L. Seger and Bruce Ramsey, president and vice president of Interstate Oil Pipe Line Company, Shreveport, Louisiana.

Doles was a station agent and telegraph operator on the Midland Valley Railroad in 1909 when Oklahoma Pipe Line Company started construction of its original crude oil pipe line from Glenn Pool, Oklahoma, to a point on the Arkansas state line near DeQueen. He was first employed by Oklahoma as a laborer on December 9, 1909.

The Ajax Pipe Line Corporation was formed in 1930, and began construction of a crude oil pipe line system from Glenn Pool, Oklahoma, to Wood River, Illinois, and Doles was named general superintendent of the Ajax Corporation on June 8 of that year. He served as general superintendent during the construction of the Ajax line, and on January 1, 1931, when general offices of the company were established in Springfield, Missouri, Doles was elected vice president and general manager of the company. He has continued to serve in top executive positions of Ajax since the company was organized.

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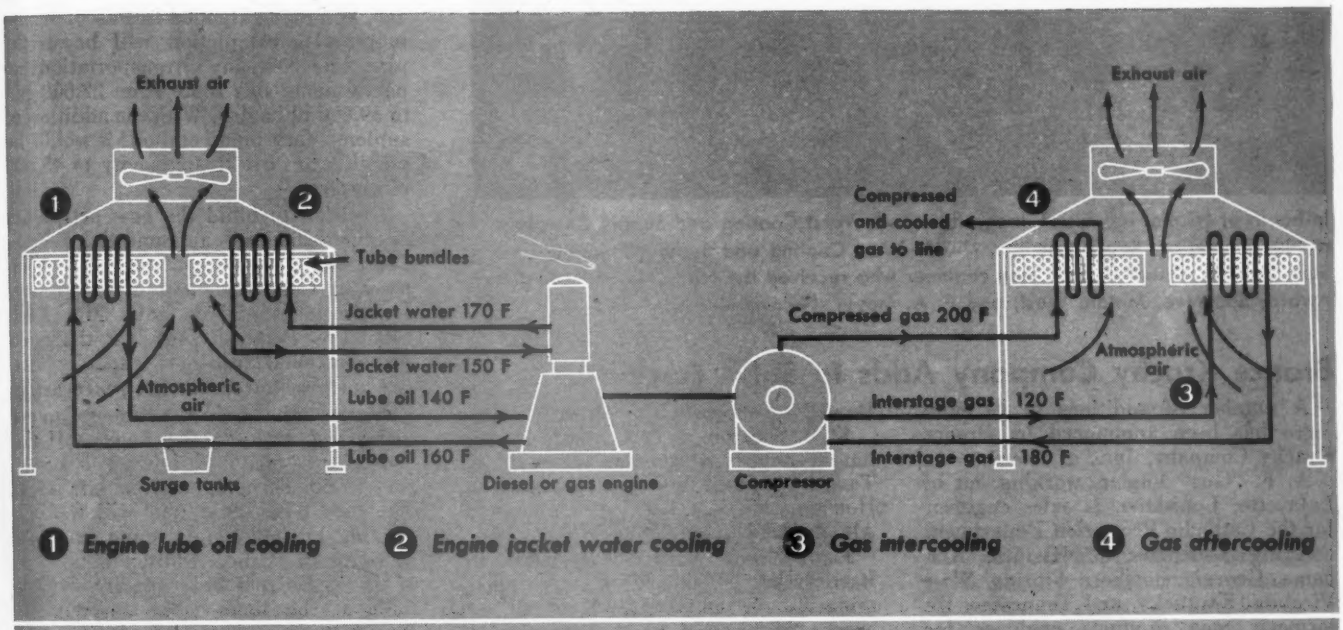

in high-pressure gas compressor stations

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To obtain more information on products advertised see page E-51

In booth of Nicolet Industries, Inc., and Middle West Coating and Supply Company at NACE meeting. Bob Hueseman, Middle West Coating and Supply Company; Starr Thayer, consulting corrosion engineer who received the Frank Newman Speller Award; Bob Nee, Middle West, and P. A. Meyer, Nicolet Industries, Inc.

Brance Krachy Company Adds to Sales Force

A number of additions to its sales force has been announced by Brance Krachy Company, Inc., of Houston.

A. F. "Gus" Vogler, working out of Lafayette, Louisiana, is sales engineer for the Cathodic Protection Department covering Louisiana, Mississippi, Alabama, Georgia, northern Florida, West Virginia, Kentucky, and Tennessee. He formerly was products engineer for Dowell Incorporated, in Tulsa.

K. B. Sherron, as sales engineer, will handle pipe coatings for the state of Texas, making his headquarters in Houston. He has been with Diamond Alkali and Dupont.

Earl Owens, with headquarters in Bartlesville, Oklahoma, is sales representative for Oklahoma, Kansas, Nebraska, Mississippi, north Arkansas.

Salt Lake Pipe Line to Lay 330 Miles of Pipe

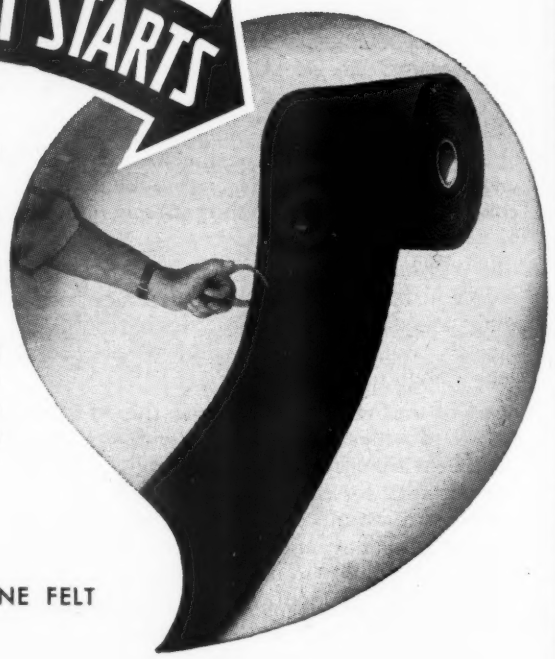
Plans for construction of a 330-mile oil products pipe line from Salt Lake City to Boise, Idaho, have been announced by Salt Lake Pipe Line Company, a subsidiary of Standard Oil Company of California.

The new line, to be built at a cost of $8,000,000, will parallel an existing pipe line route completed to Boise two years ago, and then extended to Pasco, Washington. Its completion will boost the pipe line company's transportation capacity along this route from 22,000 bbl to 39,500 bbl a day. With the addition of suplementary pump stations it would be possible to raise this capacity to 45,000 bbl a day.

Decision to build the new petroleum products line was announced by T. S. Petersen, president, Standard Oil Company of California, and C. E. Finney, Jr., president of Salt Lake Pipe Line Company. Petersen said that the need for additional transport capacity into the northwest area has been increasing.

Work on the project is expected to get under way within a few months, if the steel pipe is made available. It is hoped that it can be completed by late 1952. The new 8-in. diam line will tie into existing take-off points along its route in southern Idaho. Additional tankage of about 200,000 bbl capacity will be built at the line's Boise terminal to handle the increased flow of oil.

STOP CORROSION BEFORE IT STARTS



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Contracts Awarded for Rancho Pipe Line System

Contracts have been awarded for construction of the 435-mile, 24-in. main line of the Rancho Pipe Line System across Texas, and the contracts were awarded to Anderson Brothers Corporation and Houston Contracting Company, both of Houston, Texas.

Completion of this new major trunk pipe line is scheduled by December 1, 1952, at an estimated cost of about $35,000,000.

The multiple-ownership project, with seven companies participating, will be designed, constructed and operated by the Shell Pipe Line Corporation. Other participants include Sinclair Pipe Line Company, Pan American Pipe Line Company, Phillips Pipe Line Company, Nantucket Pipe Line Company (a wholly owned subsidary of Eastern States Petroleum Corporation, Inc.), Crown Central Petroleum Corporation, and Ashland Pipe Line Company.

Anderson Brothers will lay the 267-mile western section of the trunk line from McCamey, Texas, to Cedar Valley, a few miles west of Austin. Houston Contracting will install the remaining 188 miles to Houston, including dual crossings of the Colorado and Brazos Rivers. The western portion of the line will be laid through what is principally rocky grazing land, and the eastern segment will traverse agricultural, urban, and industrial areas.

The route of the new line parallels that of Shell Pipe Line's 24-year-old 10-in. line from McCamey to a point near Sealy, then on to Houston by a new route that will, insofar as possible, avoid urban development.

A contract has been awarded to Chicago Bridge and Iron Company for erection of 1,200,000 bbl of tankage at McCamey, but the three pump stations near McCamey, Eldorado, and Austin will not be contracted until later.

The line will have an initial throughput capacity of 210,000 bbl a day. The number of pump stations eventually may be increased to eight, giving it a capacity of 345,000 bbl per day.

Atlantic Seaboard Would Acquire Company

The Federal Power Commission has been asked to authorize Atlantic Seaboard Corporation, of Charleston, West Virginia, to acquire and operate all natural gas transmission facilities of its subsidiary, Virginia Gas Transmission Corporation, also of Charleston. Both are affiliated companies of The Columbia Gas System, Inc.

The companies said they were submitting the application in order to bring about unitization of corporate structures and a simplification of existing transmission operations, from which substantial savings would be realized. No new markets are proposed in the application.

Seaboard and Transmission each own and operate sections of a continuous 421-mile 20-in. gas transmission line extending from Boldman, Kentucky, to the Maryland-Pennsylvania state line, and a 262-mile 26-in. line from Clendenin, West Virginia, to a point near Rockville, Maryland. Transmission owns and operates the Virginia sections of the lines, and Seaboard owns and operates the sections in Kentucky, West Virginia, and Maryland.

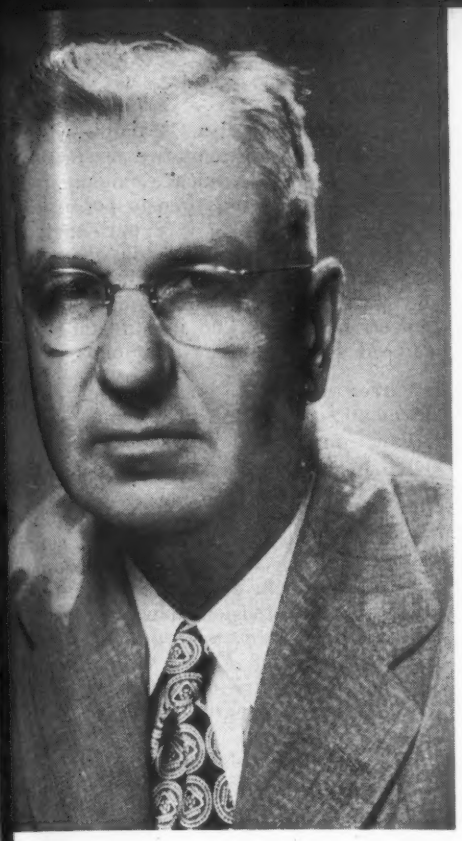
Under the companies' proposal, Transmission would declare a dividend to Seaboard in the amount equal to its earned surplus since September 30, 1946. As owner of all the outstanding securities, Seaboard would then cause Transmission to be dissolved and would take over all of the latter company's assets and liabilities.

Seaboard plans to continue, without interruption, all services presently being rendered by Transmission.

Executive Committee Completes Plans for Annual Short Course

The executive and general committees of the Southwestern Gas Measurement Short Course, at a meeting in the board room of the Northern Natural Gas Company in Omaha, Nebraska, recently, completed plans for the 1952 Short Course, which is to be held at the University of Okalhoma, North Campus, Norman, Oklahoma, May 27, 28 and 29, 1952. At this meeting, the dates for the 1953 Short Course were set for April 21, 22, and 23.

PIPE LINE PERSONALS



Smith W. Day

The retirement on March 1 of S. W. Day, vice president of Interstate Oil Pipe Line Company, Shreveport, Louisiana, climaxed a career that began 47 years ago in New Jersey, when he was first employed as a laborer by the New York Transit Company on June 1, 1905.

Fellow employees, friends, and prominent members of the oil and pipe line industries attended a banquet Tuesday evening, March 11, at the American Legion Club in Shreveport, which was given in honor of the veteran executive. In addition to employees from virtually all parts of Interstate's operations in seven states, a number of oil and pipe line company officials attended the banquet, including B. B. Howard, director of Standard Oil Company (New Jersey); W. R. Finney, pipe line advisor of Jersey Standard; L. F. Kahle, deputy coordinator of transportation activities of Jersey Standard, all of New York City; J. A. Neath, vice president, Humble Oil and Refining Company, Houston, Texas; O. Q. Lomax, president of the Humble Pipe Line Company, Houston, Texas; Cecil Morgan, vice president of Esso Standard Oil Company, New York City; H. J. Voorhies, vice president of Esso Standard and general manager of the Esso refinery at Baton Rouge, Louisiana; Charles Leet, assistant manager of the Esso refinery at Baton Rouge; A. E. Pecore, vice president and general superintendent, Humble Pipe Line Company, Houston, Texas; J. R. Doles, vice president, Ajax Pipe Line Corporation, Springfield, Missouri, and G. A. Wilson, president, Interstate Natural Gas Company, New Orleans.

Starting his career as a pipe line laborer in 1905, Day spent the first four years of his career working in various capacities in pipe line construction work for different affiliates of Standard Oil Company (New Jersey). At various times he worked for New York Transit Company, Prairie Oil and Gas Company, A. C. Bedford Company, and the Southern Pipe Line Company. He served in capacities ranging from laborer to connection foreman in New York, New Jersey, Pennsylvania, Illinois, and Missouri.

In June, 1909, when Standard Oil Company of Louisiana began construction of a pipe line from the Arkansas state line to Baton Rouge, Day went to work on the proposed line. For several months he served in a number of construction capacities. Before the line was completed, however, important oil production was discovered near the new trunk line route, and construction of gathering facilities began assuming more importance to the Louisiana company.

Day was promoted to connection foreman in April, 1910. On January 1, 1914, when he was in the DeSoto field area, Day was named district foreman, and at the beginning of 1920 was called into Standard of Louisiana's pipe line department headquarters to serve as superintendent of gathering lines.

He continued in that capacity, after Standard Pipe Line Company succeeded the pipe line department of Standard of Louisiana, until January 1, 1928, when he was elected vice president of the successor company. Upon merger of Standard Pipe Line with Standard Oil Company of Louisiana in September, 1936, Day served briefly as assistant manager of the pipe line department before being elected vice president and general manager of the pipe line department of Standard Oil Company of Louisiana on May 1, 1937.

When Interstate Oil Pipe Line Company acquired Standard of Louisiana's pipe line properties on January 1, 1945, Day was elected vice president and a director of Interstate, and continued in that capacity until he retired.

Day will continue to live in Shreveport where he and Mrs. Day, the former Margaret George, recently completed a new home at 5 Lake Forest Hills.

▸ **Robert Allen** has recently been made general manager of the Pipeline Coating and Engineering Company, Huntington Park, California, manufacturers of rubber tapes, rubber mastics, pipe line insulators, and casing seals. He formerly was with Continental Can Company and Reed Roller Bit Company.

▸ **H. C. Price,** president of H. C. Price Company, Bartlesville, Oklahoma, Mrs. Price, and their son, Joe, recently returned from an extended tour of the south and southwest Pacific. They left in January, returning in March.

▸ **G. Barrett Herr** of Pittsburgh, Pennsylvania, has been named deputy director of the Gas Facilities Division of the Petroleum Administration for Defense, Secretary of the Interior Oscar L. Chapman announces.

Herr will serve as deputy director of the division until April 17. He will then succeed Louis C. Sonnen as director of the division. Sonnen, who has been with PAD since April 17, 1951, will return to his post as vice president in charge of purchasing for the Tennessee Gas Transmission Company, Houston, Texas.

Herr, born in Oil City, Pennsylvania, has been associated with various phases of the oil and gas industry since being graduated from Findlay, Ohio, high school in 1916. For two years he was employed by the Ohio Oil Company in Findlay and Wooster, Ohio, as a roustabout, pumper, and storekeeper.

In November, 1923, he joined The Peoples Natural Gas Company of Pittsburgh and has been in the employ of the company ever since, working throughout the entire Consolidated Natural Gas Company system.

For 14 years he was chief district field supervisor in charge of production transmission and distribution district offices and for four years he was traveling field supervisor for the company. During World War II he was supervisor of priorities for the company, then after the war became superintendent of stores. Herr has been active in the materials and supplies committee of the American Gas Association for eight years, three years of which he served as chairman.

Herr is on leave from the latter position and will serve without government compensation.

▸ **Leslie Laws** has been made eastern division engineer in the pipe line department at Maumee, Ohio, by Panhandle Eastern Pipe Line Company. He formerly was a pipe line department engineer in the Kansas City office. **Jack White** has been made western division engineer with headquarters at Paola, Kansas. He also was in the engineering department at Kansas City. **S. R. Phillips,** former district foreman at Zionsville, Indiana, takes over the same post at Glenarm. **Harold K. Ford** goes to Zionsville. He has been at Glenarm as foreman.

In the compressor station department, **Charles Amick,** former resident engineer at Edgerton, Indiana, has been named eastern division engineer with headquarters at Crawfordsville, Indiana. **Fayette Botts,** former resident engineer at Zionsville, has been named central division engineer at Jacksonville, Illinois. He replaces **Kenneth E. Kalen** who becomes compressor department engineer in Kansas City. **Robert W. Yarnell** becomes western division engineer at Newton, Kansas. He has been resident engineer at Olpe, Kansas.

Personals

Ralph H. Starrett has been promoted to division superintendent in the Products Pipe Line Department of Standard Oil Company (Indiana). **Francis W. Mann** succeeds him as district superintendent at Council Bluffs, Iowa. **L. E. Achterberg** has been appointed superintendent of right-of-way and claims division of the products pipe line department.

Starrett began his service as a welder helper in 1930 and became a connection foreman at Rensselaer, Indiana, in 1941. After becoming assistant district superintendent at Minneapolis, Minnesota, he was advanced to district superintendent at Minneapolis in 1947. In 1950 he was transferred to Council Bluffs as district superintendent. In 1951 he was placed in charge of construction of the Neodesha, Kansas-Sugar Creek, Missouri, pipe line.

As division superintendent Starrett will be in charge of the new Neodesha-Sugar Creek pipe line and the present pipe line facilities extending from Sugar Creek to Sioux Falls, South Dakota, and Des Moines, Iowa.

Mann started as a junior engineer and later served as assistant to the superintendent of the Products Pipe Line Department. In 1951 he was made assistant district superintendent at Council Bluffs. As district superintendent at Council Bluffs he will be responsible for the operation and maintenance of the products pipe line facilities from Sugar Creek to Sioux Falls and Des Moines.

Mann was graduated from Colorado School of Mines as a petroleum engineer. He served in the U. S. Army Corps of Engineers from 1943 to 1946 in a pipe line construction and operation battalion. When released from the Army he held the rank of captain.

Achterberg, who has had 25 years' experience in right-of-way and claims work, was formerly field superintendent-right-of-way and claims for Service Pipe Line Company.

He was in charge of purchasing right-of-way for the new Neodesha-Sugar Creek pipe line.

J. A. Fowler, former field supervisor, has been appointed superintendent of communications by Panhandle Eastern Pipe Line Company. The communications department was formerly under the supervision of **F. J. McElhatton,** superintendent of compressor stations. It will now function as a distinct service department.

Fowler joined Panhandle Eastern in 1945 as a radio engineer and became field supervisor in 1947. For the last 17 months he has been in charge of installing the new microwave communications system.

In another personnel change, **John McCart,** former district foreman at Glenarm, Illinois, was transferred to the Kansas City office as operations supervisor. In this capacity he will assist **D. K. Stephens,** superintendent of pipe lines, and **J. C. Wright,** assistant superintendent of pipe lines.

H. D. Bryan

H. D. Bryan has been named sales manager, Cleaner Pipelines Company. He is a graduate of Carnegie Institute of Technology in industrial engineering. In 1946 he was employed by Ludlow Valve Manufacturing Company as sales engineer in the Pittsburgh office and was transferred to the Houston office in 1950 as branch manager.

Cleaner Pipelines is engaged in the sale of internal pipe line cleaners, night caps, squeegees, and other pipe line accessories.

Joseph F. McCarthy has been appointed assistant division superintendent for Humble Pipe Line Company's Southwest Texas Division, with headquarters in Corpus Christi.

At the same time, the appointment of **Francis W. Leary** and **William W. Brooks** as district superintendent and assistant district superintendent respectively for the company's Alice district was announced. All three men joined Humble Pipe Line Company in 1927.

McCarthy began as a pipeliner at the Ingleside station. In 1941 he was sent to Montreal, Canada to aid in the construction of a line from Portland, Maine, to Montreal. He was on loan to the Petroleum Administration for War in Washington, D. C., as a pipe line consultant during World War II. In 1944 he returned to Corpus Christi and has since served in several supervisory positions in the Southwest Texas Division.

Leary, a graduate of Notre Dame University, started with Humble Pipe Line Company as a clerk in Sonora. He became assistant district superintendent in Alice in 1945 and acting district superintendent in 1951.

Brooks attended New Mexico A. & M. College. He went to work for the company as an oiler at the Navasota station. In 1951 he was made acting assistant district superintendent in Alice.

Raymond A. Metzke of Beaumont, Texas, formerly district manager for United Gas in New Braunfels, is returning as manager of the company's Southwest Texas distribution division to succeed W. R. Briggs who died January 12, it is announced by **H. P. Carroll** of Houston, operating vice president of United's Texas distribution division.

For the last two years Metzke was operating manager for the company in the Beaumont division. His promotion was effective March 1.

Frank McNulty, Tulsa, Oklahoma, who has been sales representative for Pittsburgh Coke and Chemical Company, is now devoting his full time to personal business interests. He is a partner in Elder and McNulty, Tulsa, who operate a service for X-raying pipe line welds, and the Protecto Wrap Company of Denver, Colorado, who manufacture a material for wrapping pipe joints.

Warren R. Deel, former chief engineer at Service Pipe Line Company's Kadane pump station, has been promoted to division machinist with headquarters at Bowie, Texas.

In addition to a trunk line pump station, the company has an equipment repair building at Bowie. Deel, with **J. R. McClintock,** also a Service Pipe Line Company division machinist, will maintain the company's equipment in the Bowie district. **F. M. Willenburg,** Fort Worth, is division manager, and **J. P. Bradley,** superintendent of the district.

J. M. Turner, district gager, will be in charge of the semi-automatic Kadane station.

Ray E. Cartmill, Hays, Kansas, has been transferred to Casper, Wyoming, by the Service Pipe Line Company, where he will represent the company in all matters relating to pipe line right-of-way in Wyoming. He replaces **John B. Seaton,** deceased. **George L. Dye,** Shawnee, Oklahoma, has been promoted to division right-of-way man at the same location. He succeeds **F. O. Rudy,** retired.

Northern Natural Gas Announces Promotions

Northern Natural Gas Company has announced the election of P. A. Gass, former superintendent of pipe lines, to the newly created post of vice president in charge of personnel.

The creation of the new executive post was necessitated by the rapid growth of the company in recent years, it was stated. This growth has highlighted the importance of providing a centralized department that can devote its time to the welfare of employees.

Gass is well suited for his new position as he is known throughout Northern's seven state system. A veteran of ten years at various field locations and twelve years in Northern's Omaha office as superintendent of pipe lines, he has a vast amount of experience.

W. B. Haas has succeeded Gass as superintendent of pipe lines. He has been with Northern since June 1, 1931, and has been assistant superintendent of pipe lines since 1943.

P. T. McDonough, former pipe line division superintendent at Ogden, Iowa, was promoted to the position of assistant superintendent of pipe lines. C. S. Tonsfeldt, former pipe line division superintendent at Clifton, Kansas, has filled the Ogden position. Filling the division superintendent vacancy at Clifton will be Ralph Cotton, who was a district foreman at South Omaha, Nebraska.

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PIPE LINE PROJECTS

Southern Natural Proposes 1254 Miles Pipe Line

Southern Natural Gas Company, of Birmingham, Alabama, has filed an application with the Federal Power Commission proposing a $76,317,300 construction program that would increase the delivery capacity of its natural gas transmission system to 1,020,000,000 cu ft a day.

The proposed project includes the construction of a total of about 1254 miles of pipe line and 22,250 compressor hp on Southern Natural's system, which presently extends from Texas through Louisiana, Mississippi, Alabama, and into Georgia.

The company's plans include a new gas supply system, with a total of about 410 miles of pipe line and 3300 in compressor hp, to bring gas from the Sandy Hook field in south Mississippi and from various fields in south Louisiana to the Gwinville field in Mississippi.

To increase the delivery capacity of its system, Southern Natural proposes to construct a total of 561 miles of pipe line and 16,550 compressor hp on its present system north and east of the Gwinville field. A total of 31 miles of loop lines would be built on existing lateral lines, and line taps and measuring stations would be constructed for the delivery of gas to lateral lines to be built by others to supply various communities in Southern Natural's present market area and new markets in Alabama, Georgia, and South Carolina.

Another station of 2400 hp is proposed to be built at Bass Junction in Georgia from which a 110-mile 16-in. line would be constructed, extending to Augusta, Georgia, with a 20-mile extension to Aiken, South Carolina. The company also plans to build a 120-mile lateral line from the proposed Macon-Augusta line to Savannah, Georgia.

Southern Natural proposes to carry out the construction program over a period of three years, beginning as soon as possible and completing the project in 1954. The project would provide capacity for the increasing requirements of Southern Natural's present customers.

Pacific Northwest Submits Revised Plan

Pacific Northwest Pipeline Corporation, of Houston, Texas, has submitted a revised plan to the Federal Power Commission for a proposed pipe line system to serve markets in the Pacific Northwest with natural gas imported from Canada, while at the same time exporting an equal amount of United States gas back across the border for consumption in Canada.

Under the company's new proposal, 250,000,000 cu ft of natural gas per day would be imported from Alberta sources into the State of Washington, with 25,000,000 cu ft of this being returned to Canada at another point on the Washington-Canadian border. Pacific Northwest also proposes to purchase 225,000,000 cu ft from Panhandle Eastern Pipe Line Company, of Kansas City, Missouri, for export to Canada at a point near River Rouge, Michigan.

Pacific Northwest is proposing to build about 828 miles of pipe line, mainly in Washington, at an estimated cost of $58,425,000 including working capital. The proposed transmission system would include 653 miles of main transmission line, 175 miles of spur or lateral lines, and three compressor stations with a total capacity of 14,080 hp. The facilities would serve the principal populated areas of Washington, including Spokane, Seattle, and Tacoma, and the Portland, Oregon, area.

The 250,000,000 cu ft a day of natural gas produced in Alberta would be transported to a point on the U. S.-Canadian border, at the northern boundary of Stevens County, Washington, by Prairie Transmission, Ltd., a subsidiary of Pacific Northwest. 25,000,000 cu ft of this gas would then be returned by Pacific Northwest to Prairie Transmission at a point on the international boundary adjacent to Whatcom County, Washington, for delivery to Vancouver in British Columbia.

The 225,000,000 cu ft per day to be purchased from Panhandle would be delivered to Pacific Northwest at a point on the international boundary near River Rouge, Michigan, for redelivery to Canadian Natural Gas Pipe Lines, Ltd., for transmission into Ontario and Quebec.

In its original application, filed June 29, 1950, Pacific Northwest proposed to construct a 2175-mile pipe line system that would have linked the Texas gas reserve areas with gas fields in Alberta to serve the Pacific Northwest area. The company proposed to construct, at an estimated cost of $174,186,602, a Texas-to-Washington transmission line, together with facilities to carry other gas exported from Canada.

Hearings on the Pacific Northwest application are scheduled to begin April 8 in Washington, D. C. The company's application has been consolidated for hearing with three others which propose the importation of natural gas from Canada to serve market areas in the Pacific Northwest. The other three applications were filed by Northwest Natural Gas Company, Westcoast Transmission Company, Inc., and Glacier Gas Company.

Proposed 140-Mile Line For Arkansas and Missouri

Arkansas-Missouri Power Company, of Blytheville, Arkansas, has applied to the Federal Power Commission for authority to construct approximately 140 miles of pipe line to provide natural gas service to 13 communities in Arkansas and 5 in Missouri.

Arkansas-Missouri is proposing to construct two transmission lines near the Arkansas-Missouri state line extending from connections with Texas Eastern Transmission Corporation's system. One of the lines would connect with Texas Eastern's system just west of the St. Francis River in Clay County, Arkansas, and extend southwest to Rector, Arkansas. The other would connect with Texas Eastern's system near Campbell, Missouri, and extend generally south crossing from Missouri into Arkansas at a point near Blytheville, and terminating at Evadale, Arkansas.

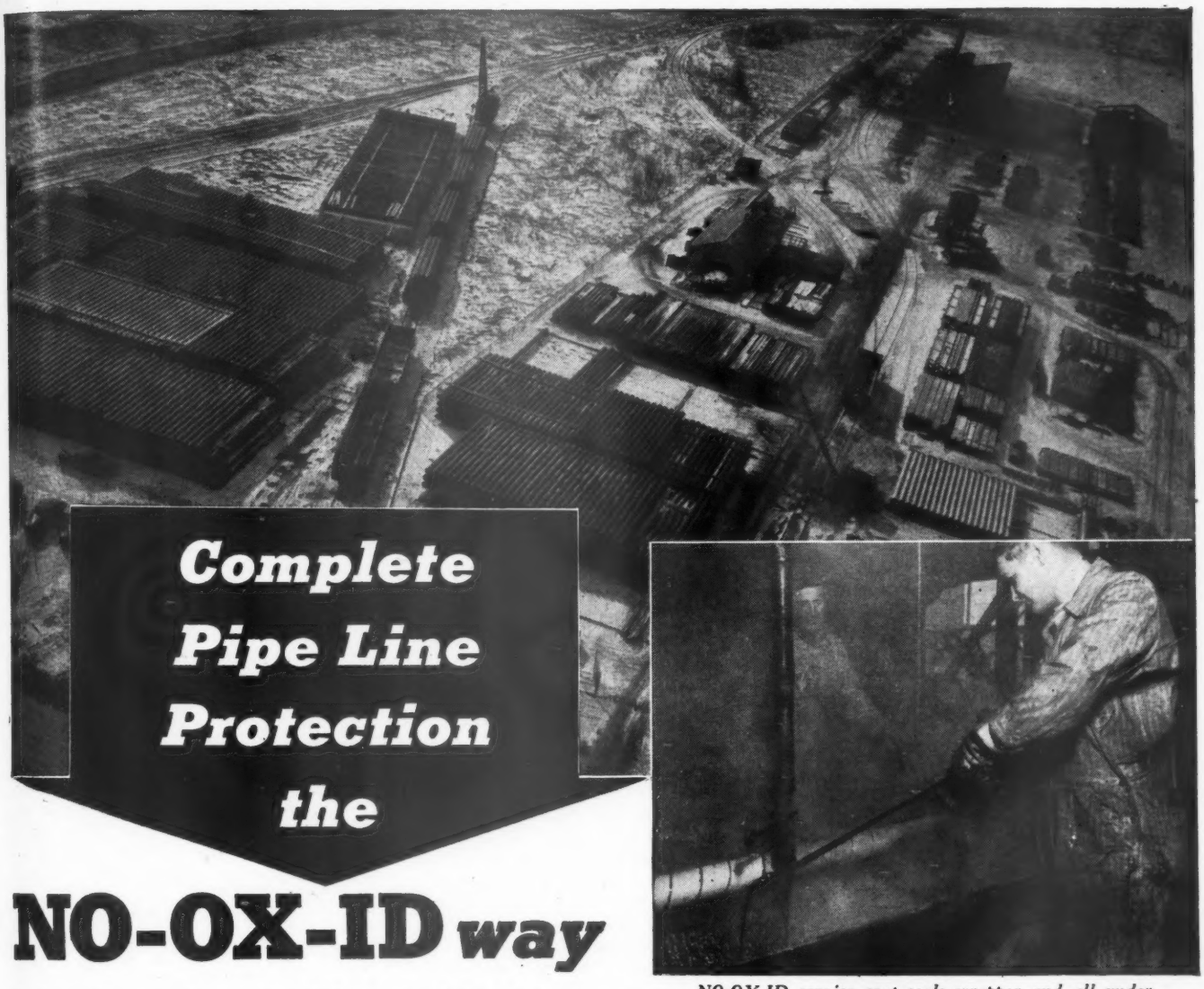
The total estimated cost of the proposed construction, including transmission lines and distribution systems, is $4,090,835. The company said it has a contract with Texas Eastern for a supply of 6,308,000 cu ft of gas a day for use on the proposed system, as authorized by the FPC in an earlier proceeding.

Mississippi River Fuel Application Dismissed

The Federal Power Commission has dismissed without prejudice an application by Mississippi River Fuel Corporation, of St. Louis, Missouri, to install additional compressor units on its pipe line system in Arkansas and Missouri.

The company recently advised the commission that it could not supply supplemental information that had been requested in connection with the application. Mississippi said that it planned to file a new or amended application, which would change the proposed project entirely, and that it had no objection to the dismissal of the pending application.

The company had proposed to install, at an estimated cost of $5,500,000, additional compressor units totaling 22,000 hp in eight previously authorized compressor stations and 5500 hp in a new station. The facilities were to be used to meet increased demands of present customers.



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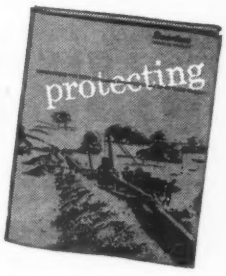

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Hearing Begins on Tennessee Gas Proposal

The Federal Power Commission began a consolidated hearing in Washington, D. C., April 1 on several applications relating to the proposal of Tennessee Gas Transmission Company, of Houston, Texas, to construct pipe line facilities that would increase its authorized design delivery capacity from 1,310,000,000 cu ft of natural gas a day to a new total of 1,515,000,000 cu ft.

The applications consolidated for hearing with the Tennessee proposal include those of East Tennessee Natural Gas Company, of Chattanooga, Tennessee; United Natural Gas Company, of Oil City, Pennsylvania; The Manufacturers Light and Heat Company, of Pittsburgh, Pennsylvania; and United Fuel Gas Company of Charleston, West Virginia; Republic Light, Heat and Power Company, Inc., of Buffalo, New York, and the City of Clarksville, Tennessee.

Tennessee's proposed construction program—similar to one for which the company refused to accept an FPC certificate last summer—includes about 591 miles of parallel loop along its existing system; approximately 304 miles of 24-in. line from the Mercer, Pennsylvania, area to a point near Utica, New York; about 137,000 hp in existing or authorized compressor stations and 28,000 hp in new stations, and approximately 250 miles of miscellaneous lateral lines. Estimated cost of the project is $128,216,000.

The facilities would be used, among other things, for the transfer of a daily delivery of 25,000,000 cu ft of gas from Tennessee's eastern rate zone, where the gas has been delivered to United Fuel for the account of Manufacturers, to its northern rate zone, for direct delivery to Manufacturers. The United Fuel and Manufacturers applications relate to this proposal. The FPC on February 15 granted a 60-day temporary certificate authorizing the transfer of delivery.

Tennessee also is proposing to provide an additional 40,000,000 cu ft of gas a day to East Tennessee, whose application also was consolidated into the April 1 hearing. East Tennessee is proposing to build, at an estimated cost of $5,200,000, a 100-mile 16-in. pipe line from a point south of Knoxville to the Kingsport, Tennessee, area, with necessary connections, laterals, meters, and regulating and measuring equipment.

Tennessee's proposed new facilities also would be used to supply an additional 15,000,000 cu ft a day each to United Natural, Equitable Gas Company, and Iroquois Gas Corporation; to deliver an additional 65,000,000 cu ft to Northeastern Gas Transmission Company in New England, and to provide additional gas for the proposed Hebron storage project in Potter County, Pennsylvania, and for existing customers.

The storage project, which would provide Tennessee with an additional 200,000,000 cu ft of peak day delivery capacity, is to be carried out jointly with United Natural at an estimated cost of $7,400,000. The United Natural application, which was consolidated with the April 1 hearing, relates to the storage project and to the additional 15,000,000 cu ft of gas that it would receive from Tennessee.

Republic Light, Heat and Power Company has asked the FPC to order Tennessee to deliver 1,000,000 cu ft of gas a day in addition to the 600,000 cu ft it now receives, and the City of Clarksville is seeking a commission order directing Tennessee to supply gas to Clarksville from its transmission line about 25 miles southeast of the city.

Ohio Fuel Gas Asks To Build 33-Mile Line

The Ohio Fuel Gas Company, of Columbus, Ohio, has asked the Federal Power Commission to authorize the construction of 33 miles of 20-in. pipe line to replace approximately 42 miles of existing 8⅝ and 10¾-in. pipe in Crawford, Wyandot, and Seneca Counties, Ohio.

The company said the proposed construction of the new line, and the retirement of the existing facilities, is required for protection of service to the Findlay, Tiffin, and Fostoria, Ohio, market areas. The new line, which would extend between existing lines at points in Jefferson Township, Crawford County, and Seneca Township in Seneca County, is estimated to cost $1,400,000.

Colorado Interstate to Increase System Capacity

The Federal Power Commission has authorized Colorado Interstate Gas Company, of Colorado Springs, Colorado, to construct natural gas transmission facilities that will increase its pipe line system capacity from about 368,000,000 cu ft a day to approximately 452,000,000 cu ft a day.

The commission, however, conditioned the authorization by directing the company not to attach any new customers or to render any additional service to its existing customers beyond that shown in exhibits presented at the hearing for 1952 and 1953.

The commission last December granted temporary authorization to the company for the facilities proposed in the project for construction in 1951. These facilities, estimated to cost $1,945,700, include additional compressor units at the company's Panhandle field compressor station, increasing its installation from 4800 hp to 6600 hp; installation of an additional 1320 hp unit at its Kit Carson (Colorado) compressor station, and the construction of about 52 miles of main line loop and lateral lines in Colorado.

The facilities to be constructed in 1952 include two additional 1320-hp units at the Panhandle field station, and one additional 1320-hp unit at the Kit Carson station to bring the total installed horsepower there to 11,040. Estimated cost of these facilities is $1,433,832, bringing the cost of the entire project to $3,379,532.

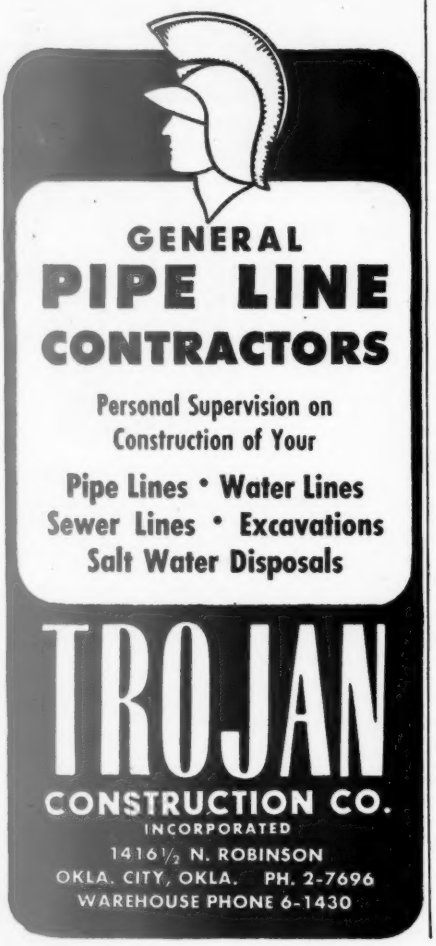
Hearing Involving Gas Carrier Is Postponed

The Federal Power Commission hearing, previously scheduled to begin March 4 in Washington, D. C., has been postponed to a date to be fixed by further order, in the consolidated proceedings on four applications involving proposed pipe line facilities to provide additional natural gas to market areas in New Mexico, Arizona, and California.

The commission at the same time consolidated a fifth application with the proceedings — a proposal by Nevada Natural Gas Pipe Line Company, of Las Vegas, Nevada, to construct a 114-mile pipe line to transport natural gas to markets in Nevada.

Two of the other applications are by El Paso Natural Gas Company, of El Paso, Texas; one is by Pacific Gas and Electric Company, of San Francisco, California, and one is a joint application by Southern California Gas Company and Southern Counties Gas Company of California, both of Los Angeles.

El Paso is proposing to expand its pipe line system capacity to supply additional natural gas to the three California companies and the Nevada company. The California companies, in turn, are seeking authority to build additional facilities to enable them to transport the gas they would receive from El Paso.



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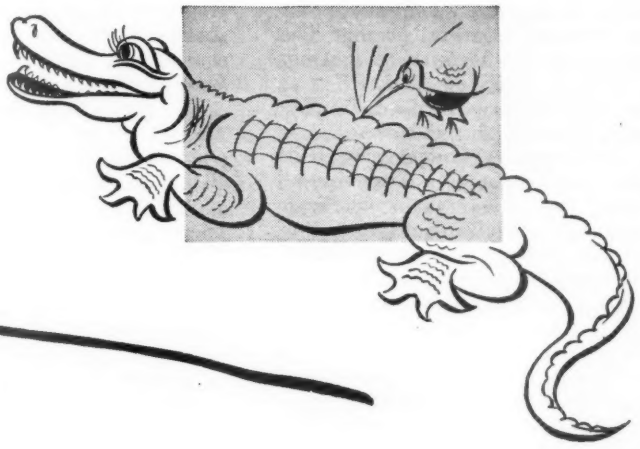

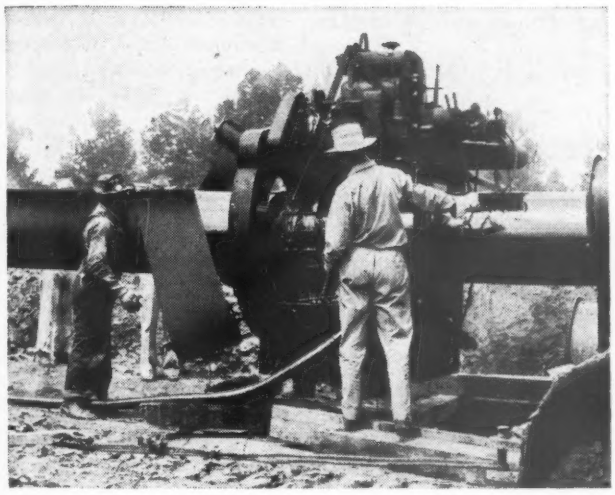

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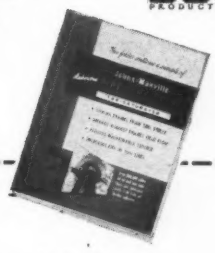

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Pipe Line Projects

Columbia Subsidiaries Would Lay New Lines

Three subsidiaries of The Columbia Gas System, Inc., have asked the Federal Power Commission for authority to construct and operate a total of approximately 94 miles of natural gas pipe lines on their transmission systems in Ohio, Pennsylvania, and New York.

The application was filed by The Manufacturers Light and Heat Company, Natural Gas Company of West Virginia, and Home Gas Company, all of which have their main offices in Pittsburgh, Pennsylvania. Manufacturers and Natural also are seeking FPC authorization to retire certain facilities. The construction would improve and increase facilities to assure continuous service and provide for expansion of service.

Manufacturers is proposing to construct a total of about 40 miles of new pipe line in Allegheny, Washington, and Beaver counties, Pennsylvania, and Belmont, Jefferson, and Columbiana counties, Ohio. The company also plans to retire approximately 34 miles of pipe line in Allegheny, Washington, and Clarion counties, Pennsylvania, and Belmont and Columbiana counties, Ohio. In addition, a compressor station in Lawrence County, Pennsylvania, and a compressor unit in Columbiana County, Ohio, would be retired.

Natural wants permission to construct a total of 21 miles of pipe line in Columbiana and Stark counties, Ohio, and to retire two compressor units in Belmont County, Ohio.

Home is seeking authority to build about 32.5 miles of pipe line in Chemung and Broome counties, New York.

Estimated net cost of the project is $3,829,677, consisting of $2,111,077 for Manufacturers, $618,600 for Natural, and $1,100,000 for Home.

Utah Pipe Line Company's Withdrawal Effective

Utah Pipe Line Company's notice of withdrawal of its application, in which it was seeking Federal Power Commission authorization to build a New Mexico-to-Utah natural gas transmission line, became effective as of February 28.

The company, which has its main office in Dallas, Texas, filed the withdrawal notice with the FPC on January 29. Under the FPC's Rules of Practice and Procedure, a notice of withdrawal becomes effective after 30 days unless otherwise ordered by the commission.

The proposed project, which had an estimated cost of $22,000,000, included a 392-mile line extending from a point near Aztec, New Mexico, to the Salt Lake City, Utah, area.

In its notice of withdrawal, the company said that Delhi Oil Corporation had disposed of its undedicated natural gas reserves in San Juan County, New Mexico, to El Paso Natural Gas Company, and that these reserves constituted the sole source of supply for the facilities proposed in the application.

Hearing Set for April 15 on 1350-Mile Line

The Federal Power Commission has scheduled a hearing to begin April 15 in Washington, D. C., on the application of Texas-Ohio Gas Company, of Houston, Texas, for authority to construct a 1350-mile natural gas transmission line extending from Texas into West Virginia.

The project, estimated to cost $184,989,683, is to be constructed in two phases, with an initial daily capacity of about 330,000,000 cu ft to be increased to 505,000,000 cu ft in the second phase. The company plans an ultimate capacity of approximately 650,000,000 cu ft per day. The proposed 30-in. line would originate in Hidalgo County, Texas, and extend through Arkansas, Mississippi, Tennessee, and Kentucky, terminating near Spencer, West Virginia. The line would have 13 compressor stations with a total of 140,000 hp.

The company, which had been granted a previous extension of time in which to file certain data and exhibits in support of its application, had requested a further 90-day extension from February 1. The commission denied that request, and said that failure on the part of the company to be fully prepared, at the start of the hearing, to prosecute its application with all supporting data, exhibits and evidence would be ground for dismissal.

In a concurrent order, the commission permitted the following petitioners to intervene in the Texas-Ohio proceeding: Texas Eastern Transmission Corporation; United Fuel Gas Company; Equitable Gas Company; Railway Labor Executives Association; Fuels Research Council, Inc.; National Coal Association and United Mine Workers of America; Louisville and Nashville Railroad Company, and Chesapeake and Ohio Railway Company.

Service Proposes Second Line from Saunders Pool

A Service Pipe Line Company application to construct a second crude oil pipe line from the Saunders pool in Lea County, New Mexico, to a connection with its West Texas system, has been approved by the Petroleum Administration for Defense.

The Saunders pool now is served by a line that pumps oil north to a company line serving the Caprock area. The new line, 26 miles of 10-in., will move oil east, via the Denton pool, to the company's West Texas system at its Wasson station.

C. M. Scott, Jr., general manager, said his company is preparing to start engineering surveys and to obtain right-of-way. He described the new construction as "a big gathering line that will act as a loop also for our northern line in Lea County."

The new line will provide adequate capacity for future production in the vicinity of the Saunders and West Saunders pools, and for the new development along the route of the line. There is considerable drilling activity in the region to the traversed.

As a phase of the new PAD-approved project, the East Caprock pool will be connected to the company's north line.

The proposed construction will give Service Pipe Line Company an extensive gathering and transportation system in northern Lea County. Lines now run from Caprock to the company's West Texas system at Slaughter station with laterals serving the Bagtower, Saunders, and Gladiola pools. A Magnolia Pipe Line Company gathering system serving the Crossroads pool is connected to the Caprock-Slaughter line also. A line runs from the Knowles pool across the Texas line to Wasson. The Denton pool already is connected to the West Texas system.

During the past year Service Pipe Line Company, a 12,000-mile crude oil system, has connected 92 new fields and pools largely in Texas and New Mexico. Another PAD-approved project, a line from Cogdell in southern Kent County to Aspermont in Stonewall County, is under construction. Contracts for several gathering lines have been awarded.

A long-lines system, most of the oil gathered by Service Pipe Line Company in Texas and New Mexico is delivered to refineries in the Kansas City, St. Louis, and Chicago areas.

Examiner Authorizes Gas Storage Plant

Federal Power Commission Presiding Examiner Samuel W. Jensch has filed a decision that if it becomes final, would authorize Washington Gas Light Company, of Washington, D. C., to construct and operate a standby gas storage plant near Rockville, Maryland.

The examiner conditioned the authorization, however, by requiring the company to use the facilities whenever they can be useful, including peak shaving to reduce the cost of gas purchased from Atlantic Seaboard Corporation, its supplier. Washington Gas Light had proposed to use the plant as a standby facility to provide gas only if a break occurred in the pipe line of the supplier.

The commission last August 9 granted temporary authorization for the company to begin construction of the plant, subject to the condition that if necessary the facilities be used to reduce the cost of gas purchased from Seaboard.

The plant, estimated to cost approximately $6,820,000, includes underground steel pipes with a storage capacity of 70,000,000 cu ft of natural gas, and propane liquid facilities having a storage capacity of 625,000 gal of propane, which, when gasified, will have a daily capacity of 30,000,000 cu ft of natural gas equivalent. Total delivery capacity of the plant is 7,000,000 cu ft of gas per hr, for a 14 or 15-hr period.

Cities Service Announces Two Pipe Line Projects

Two important 1952 construction projects for Cities Service Pipe Line Company have been announced by S. B. Irelan, president of Cities Service Oil Company (Delaware), the parent company.

Biggest of the two projects will be an 18-in. oil pipe line from Sour Lake, Texas, to the Lake Charles, Louisiana, refinery of Cities Service Refining Corporation. The new line will have a daily capacity of 150,000 bbl and will parallel the company's present 12-in. line. It is designed to fit into a program of increased oil supply to the Lake Charles refinery through projected West Texas-Gulf line in which Cities Service holds a substantial interest.

Construction of the line will involve crossing 12 miles of swamp and two rivers, the Neches and the Sabine.

Capacity of the present Sour Lake station also will be increased, seven 120,000-bbl floating roof tanks will be installed, and an office and warehouse will be built at the station. Upon completion of facilities, division headquarters of the pipe line company will be moved to Sour Lake from Beaumont, Texas.

Pipe allotment for the project is scheduled for delivery the third quarter of this year.

The other construction project announced will complete the looping of the company's Cimarron Station-Cushing line. About 20 miles of 8-in. line will be laid to permit two-way flow between Cushing and the Cimarron station.

When completed, the loop will receive Scurry County and other West Texas crudes from the Basin Pipe Line System at Cushing for delivery to Ponca City.

New York State Natural To Build New Facilities

The Federal Power Commission has authorized New York State Natural Gas Corporation, of New York City, to construct approximately 104.7 miles of natural gas transmission line in Pennsylvania and New York and to install additional 1820 hp at two existing compressor stations in Pennsylvania.

The 104.7 miles of pipe line, to be of 14, 16, and 20-in. diam pipe, will be constructed in five sections, four of which will parallel existing transmission lines, with the fifth replacing an existing line. The new sections of line will be in Westmoreland, Armstrong, Tioga, and Potter counties, Pennsylvania, and in Wyoming, Onondaga, and Cayuga counties, New York. The additional compressor horsepower will be installed at stations in Westmoreland and Tioga counties, Pennsylvania.

Estimated cost of the construction is $6,018,900.

Pipe Line Authorized For Central Ohio

The Ohio Fuel Gas Company, of Columbus, Ohio, has received authorization from the Federal Power Commission for the construction and operation of a 31.2 mile pipe line in central Ohio for the transportation of natural gas to underground storage and market areas.

The proposed 20-in. line, which has an estimated cost of about $1,440,000, will extend from Ohio Fuel's Treat compressor station in Licking County to its Weaver Storage compressor station in Richland County. The new facilities will permit storage of greater volumes of gas in the northern part of Ohio Fuel's system, where lack of gas from outside sources makes it necessary to meet winter and peak loads from storage areas.

The capacity of the company's existing facilities for transporting gas north of the Treat compressor station is estimated at 195,000,000 cu ft a day, and Ohio Fuel estimates that during July of 1952 an average of 260,000,000 cu ft a day will be required for placement into the northern Ohio storage areas. The new facilities are expected to have a capacity of 142,000,000 cu ft a day.

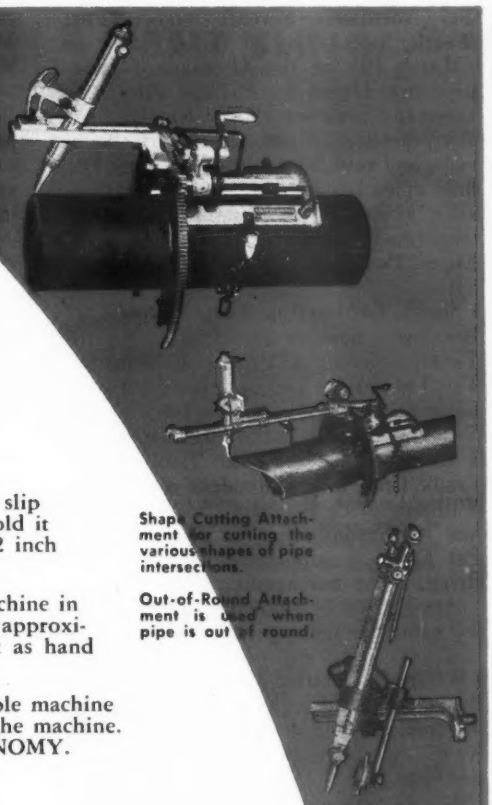
☆ ☆ ☆

Nylon is being used in a sling for handling lengths of pipe line. The fabric has chemically treated cotton cord for the warp, and nylon forms the woof. The pipe sling is flexible, can bend around small diameters without cracking.

H&M

PIPE CUTTING AND BEVELING MACHINE

Cuts and Bevels Pipe FASTER, MORE ECONOMICALLY



Split horseshoe shaped gear permits machine to slip quickly over pipe. Fast operating snap chain fasteners hold it in place. A complete cut and bevel can be made in a 12 inch pipe in about two minutes.

You'll soon save several times the cost of the machine in labor, gas and transportation charges. H&M takes approximately one-half the labor and gas to make the cut as hand cutting and the work is all done in the field.

Bring this light (24 to 155 pounds) but durable machine to the pipe instead of moving the heavy pipe to the machine. Remember, H&M designs for SPEED and ECONOMY.

Shape Cutting Attachment for cutting the various shapes of pipe intersections.

Out-of-Round Attachment is used when pipe is out of round.

See for yourself. Let us arrange a demonstration.

H&M PIPE BEVELING MACHINE COMPANY

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Phone 3-0241

With the PIPE LINE CONTRACTORS

O. R. Burden Construction Corporation, 6702 East 21st Street, Tulsa, Oklahoma, which is constructing 154 miles of 24-in. pipe line on the new Sinclair Pipe Line Company system between Cushing and East Chicago, Indiana, has moved its two spread offices. The crew under Floyd W. Lewis is now making its headquarters at Hominy, Oklahoma. Ben Mapes is office manager. The river crossing crew, presently engaged in installing the Arkansas River also has its headquarters at this point. This work is in charge of Virgil Lambert. The second mainline spread has moved to Chanute, Kansas. A. B. Haynes is superintendent and Bill Clyma office manager.

The work for Sinclair is between Cushing, Oklahoma, and Humboldt, Kansas.

On the Platte Pipe Line Company job the field office is still at Carrollton, Missouri, where A. T. Perry is superintendent, K. N. Adkins assistant superintendent, and E. Howard Smith, Jr., office manager. The section now being laid is 120 miles of 20-in. from St. Joseph to Salisbury, Missouri. In all, Burden is laying 280 miles of the Platte system, from St. Joseph to Wood River, Illinois.

Smith-Donaho Contracting Company, 205 Northwest Seventh Street, Fort Worth, Texas, has 15 miles yet to go (March 19) on the 41 miles of 10-in. pipe it is laying for Phillips Pipe Line Company between Paola, Kansas, and Warrensburg, Missouri. Bad weather, snow and rain, has slowed progress. The field office has been moved to Harrisonville, Missouri. Herb Smith is superintendent, H. E. Doyle spreadman, and Ernest Bell office manager.

Smith Contracting Corporation, 205 Northwest Seventh Street, Fort Worth, Texas, is laying 175 miles of 16-in. for The Texas Pipe Line Company between Corsicana and East Houston, Texas. Two spreads are on the job. Spread No. 1 has its field office at Teague with Frank Craig superintendent and M. E. Williams office manager. Spread No. 2 has its headquarters at Madisonville. Pat Erwin is superintendent and John Briggs office manager.

Art Renton is engineer and purchasing agent for both spreads.

Williams-Austin Company, Grant Building, Pittsburgh 19, Pennsylvania, has the following work scheduled for the New York State Natural Gas Corporation:

12 miles 20-in. loop line at Zelienople, Pennsylvania. Start April 15, completion May 15. Warehouse at Zelienople, Pennsylvania. Ralph Gaddy, superintendent, E. E. Mayes, timekeeper.

52 miles 16-in. from Utica, New York, to Amsterdam, New York. To begin at completion of Zelienople job. Ralph Gaddy, superintendent, L. A. Franks, timekeeper. Completion in 90 days. Warehouse at Herkimer, New York.

20 miles 20-in. from Cayuta Gate to Ithaca, New York. Start May 1, completion June 30. Warehouse at Ithaca, New York. Howard Bauer, superintendent, R. H. Condry, timekeeper.

20 miles 20-in. from Angelica, New York, to Rossburg, New York. To start at completion of Cayuta Gate-Ithaca job, completion in 45 days. Howard Bauer, superintendent. Warehouse to be determined later.

17 miles 16-in. from Colesburg Junction to Sabinsville, Pennsylvania. To start at completion of Angelica job. Howard Bauer, superintendent.

Ed Peters is general superintendent. The field warehouse is at Cortland, New York, Phone 23.

Williams Brothers Corporation, National Bank of Tulsa Building, Tulsa, Oklahoma, is scheduled to begin laying pipe April 1 on 143 miles of 10, 24, and 26-in. for the Algonquin Gas Transmission Company, in New Jersey, New York, and Connecticut. The central office is at Danbury, Connecticut. R. L. Buck is general superintendent, O. R. Mitchell, T. E. "Thelma" Davis, and Whitey Martin spreadmen.

Other jobs by this company are:

Central Kentucky Natural Gas Company, 10 miles of 12-in. from Lexington toward Winchester, the field office being at Lexington. R. H. Abemeyer is superintendent.

Piedmont Natural Gas Company, 18 miles of 6 and 8-in. at Greenville, South Carolina. Brownie Young is spreadman.

Public Service Company of North Carolina, 14 miles of 3, 4, and 6-in. at Adenville and Belmont; and 20 miles of 4-in. at Mooresville, Kanapolis, and Concord.

W. H. Franks is division superintendent for the last three named jobs. His headquarters are at Charlotte, North Carolina.

Minneapolis Gas Company, 30 miles of 26-in. in the city of Minneapolis. W. F. Caldwell, superintendent in charge. This job is scheduled to begin about April 15.

Atlanta Gas Light Company, city distribution system at Chamblee, Georgia. E. U. Mahaffey is superintendent.

Altgelt Construction Company, Inc., P. O. Box 1402, Corpus Christi, Texas, is laying a 25-mile gathering system for United Gas Pipe Line Company in the Agua Dulce area. Pipe sizes are 4 in. through 16 in. The field office is at Robstown. Lee Phillips is superintendent and Art Roberts office manager.

Anderson Brothers Corporation, 707 North Drennan Street, Houston, Texas, has been awarded a part of the Rancho Pipe Line System, which overall will extend from McCamey, Texas, to the Houston-Texas City area. The company will lay 267 miles from McCamey to Cedar Valley, a few miles west of Austin. The pipe will be 24 in. Work is scheduled to begin April 1 with the field office at McCamey. M. E. "Panama" Shiflett will be general superintendent.

Also scheduled to begin April 1 are 217 miles of 30-in. for Texas Eastern Transmission Corporation from Portsmouth, Ohio, to Connellsville, Pennsylvania. Four spreads will be used on this project. Field headquarters will be at Oak Hill, Ohio, Beverly, Ohio, Caldwell, Ohio, and Uniontown, Pennsylvania. Rusty Killingsworth will superintend the work.

On the new West Texas Gulf Pipe Line Company system 94 miles of 26-in. are being laid from Granbury to Wortham, Texas. One spread is working out of Hillsboro with Gene Coulter spreadman and another out of Hubbard where "Cooney" Shiflett is spreadman. "Panama" Shiflett is general superintendent over both spreads.

Comstock Midwestern, Ltd., 206 Laird Drive, Leaside, Ontario, will lay 472 miles of Trans Mountain Oil Pipe Line Company's 693-mile, 24-in. system between Edmonton, Alberta, and Vancouver, British Columbia. This contractor will construct the eastern and western portions of the line. Right-of-way work will begin as soon as weather permits and pipe laying about June 1.

The contractor is laying 235 miles of line for the Sarnia Products Pipeline Company, subsidiary of Imperial Oil, Ltd., from Sarnia to Toronto. The pipe is mostly 10 and 12 in. The field office is at Strathroy, Ontario. Denver Franklin is superintendent, J. A. Kippan assistant superintendent, and E. C. McFadden office manager.

Lewie Montgomery Trucking Company, Box 432, Odessa, Texas, is stringing 84 miles of 2-in. through 24-in. pipe for Bishop and Lock. The latter is general contractor for a gathering system in the Pegasus field, Upton County, Texas, for Magnolia Pipe Line.

Mannix, Ltd., Calgary, Alberta, will construct approximately 221 miles of the Trans Mountain Oil Pipe Line Company's system, which overall will extend 693 miles from Edmonton, Alberta, to Vancouver, British Columbia. The section will be in the center of the line. Right-of-way clearing will begin as soon as weather permits. Pipe laying is scheduled to begin about June 1. The line will be constructed of 24-in. pipe.

Knapp Brothers Construction Company, Box 225, Oxford, Kansas, expects to complete about the middle of April the reclaiming of 20 miles of 6-in. pipe line for Service Pipe Line Company between Neodesha and New Albany Junction, Kansas.

Western Construction Company, P. O. Box 1135, Hobbs, New Mexico, has contracted to take up 50 miles of 8-in. and lay the same amount of pipe for Continental Pipe Line Company between Port Isabel and McAllen, Texas. The field office is at Harlingen. Morris Lassley is superintendent in charge of the work.

Pipe Line Construction and Drilling Company, Camp Hill, Pennsylvania, was scheduled to begin on April 1 the laying of 23 miles of 16 and 20-in. for New York State Natural Gas Corporation. The field office is at Waynesburg with M. E. McClure the superintendent.

For Tuscarora Oil Company, Ltd., 46 miles of 10-in. pipe is being laid from Midland to Russelton, Pennsylvania. The field office is at Sewickley. M. L. Foudray is superintendent and Fred Droddy, Jr., office manager.

For the Peoples Natural Gas Company, approximately 100 miles of 6 and 8-in. pipe is being taken up between Center Bridge and Reading, Pennsylvania. The field office is at Buckingham Valley. Lee Ross is superintendent and William F. Johnson office manager.

R. H. Fulton and Company, P. O. Box 1526, Lubbock, Texas, is laying 573 miles of 20-in. on the Platte Pipe Line Company system, the section being from Worland, Wyoming, to Holdrege, Nebraska. The field office is at Scottsbluff, Nebraska. A. A. Carrigan is superintendent and Dave Wagner office manager.

A contract has recently been awarded to the company to construct 180 miles of 24-in. on Sinclair Pipe Line Company's new system. This will be from Humboldt, Kansas, to Salisbury, Missouri. A field office has been opened at Iola, Kansas, where M. L. Boyd is superintendent, and another at Warrensburg, Missouri, where Jerry Nash is in charge.

Gulf Southern Contractors, 516½ Louisiana Avenue, Shreveport, Louisiana, have the overall contract to lay approximately 1000 miles of pipe line for United Gas Pipe Line Company in Louisiana, Texas, and Mississippi. Gulf Southern is a contracting group consisting of River Construction Corporation, Fort Worth; Oklahoma Contracting Company, Dallas; J. Ray McDermott and Company, New Orleans, and Morrison-Knudsen Company, Boise, Idaho.

Midwestern Constructors, Inc., 105 North Boulder, Tulsa, Oklahoma, has completed about 70 per cent of the work at Edgerton, Indiana, for Panhandle Eastern Pipe Line Company, consisting of the installation of two additional compressor units. K. L. Kreamalmyer is in charge. At Tuscola, Illinois, where one unit is being installed, the work is approximately 95 per cent completed. H. H. Voss is in charge of the office.

At Bauxite, Arkansas, considerable pipe fabrication and installation work is being done for the Aluminium Ore Company.

Sheehan Pipe Line Construction Company, 529 National Bank of Tulsa Building, Tulsa, Oklahoma, has just gotten underway with 18 miles of 6-in through 12-in. for the Ohio Oil Company. The section is from Palestine to Stoy, Illinois.

Trojan Construction Company, 1416½ North Robinson, Oklahoma City, Oklahoma, is laying a 12-in. line for Oklahoma Natural Gas Company between Enid and Ringwood.

Western Pipe Coating Company, Inc., P. O. Box 181, Iola, Kansas, is sub-contractor for coating and wrapping the Sinclair Pipe Line Company 24-in. line between Cushing, Oklahoma, and Humboldt, Kansas, a distance of 154 miles. The prime contractor is O. R. Burden Construction Corporation. C. M. "Peewee" Vaughan is superintendent and H. W. Carey foreman of the south spread, which has the section from Cushing to Caney, Kansas. The north spread, from Caney to Humboldt, is in charge of Cecil D. Carey as superintendent and T. W. Branstetter foreman. Ralph Sinclair is office manager for both spreads.

Bishop and Lock Construction Company, 1018 Magnolia Building, Dallas, Texas, has sold its contract with Platte Pipe Line Company to Fulton and Brodie. The section was 142 miles of 20-in. between Holdrege and Odell, Nebraska. Meanwhile, work is progressing on the 82 miles of 3½ through 24-in. pipe being laid for Magnolia Pipe Line Company in the Pegasus field of West Texas. The job is about half completed. The field office is at Odessa where Howard Laquey is superintendent and Bob Stiles office manager.

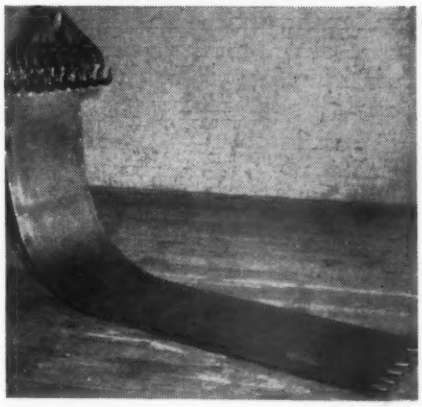
Fulton and Brodie, P. O. Box 2064, Amarillo, Texas, have begun work on 142 miles of 20-in. for Platte Pipe Line Company, between Holdrege and Odell, Nebraska, near the Kansas-Nebraska line. This is the section that was to have been laid by Bishop and Lock Construction Company, the contract being purchased by Fulton and Brodie. A field office has been established at Fairbury, Nebraska. J. T. "Jake" Brodie is superintendent, Clyde Peters spreadman, and Mrs. J. T. Brodie office manager.

L. E. Farley, Inc., 2609 Sunset Boulevard, Houston, Texas, expects to complete in April 40 miles of 16-in. being laid for United Gas Pipe Line Company between Bay Minette, Alabama, and Pensacola, Florida. This line will parallel the company's existing 12-in. system. The field office is at Bay Minette with L. W. "Doc" Barton superintendent, J. W. Hartwick assistant superintendent, and Wallace Campbell office manager.

Oklahoma Contracting Company, 6512 Hines Boulevard, Dallas, Texas, now has two mainline spreads and a river crossing spread working on the United Gas Pipe Line Company job in South Texas. Overall the work consists of 293 miles, of which 240 miles is 30-in. and 53 miles of 24 in., extending from Agua Dulce to a point northeast of Goodrich. The spread working out of Rosenberg is in charge of Louis Visentine with Buck McIntyre assistant superintendent and Dick Mueller office manager. Raymond Law is superintendent of the mainline spread that has its headquarters at Victoria and Henry Turner is office manager. Ed Flannagan is now in charge of river crossing work, also making its headquarters at Victoria. His crew recently completed the Guadalupe River crossing and is working on the Trinity.

Associated Pipe Line Contractors, Inc., 3272 Westheimer Road, Houston, Texas, is working two spreads on the 120 miles of 26-in. for West Texas Gulf Pipe Line Company from Granbury to a point about 15 miles west of Abilene, Texas. L. H. Gray is superintendent and Jack Bradley office manager for the spread that has its headquarters at Stephenville. The second spread has its field office at Cisco, Texas, where Willie Briley is superintendent, E. M. Christine assistant superintendent, and Jack Bradley office manager.

NEW WIRE ROPE
BELT SLING



Patent Pending

The only Belt Sling specially designed for Pipe Liners. Surpasses all other Belts in strength and dependability. Easily connected by one man by elimination of heavy bolt. Sizes 10" through 36".

Phone, wire, write for full information

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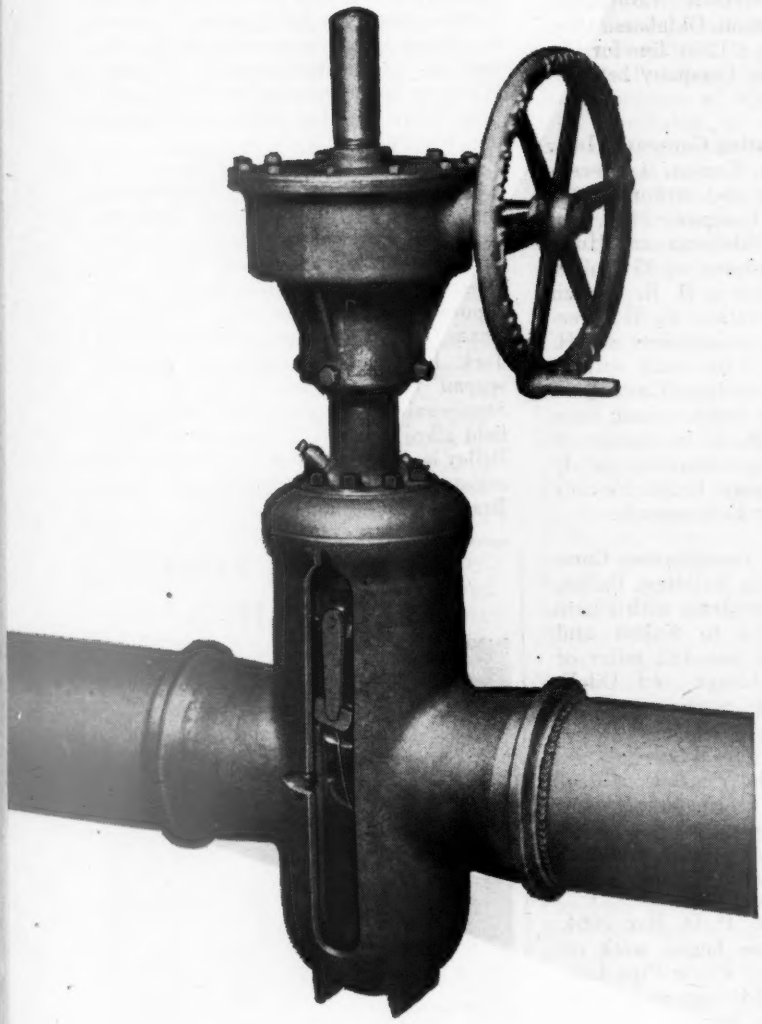
134 Sacramento St., San Francisco 11, Calif.

First with W-K-M
Only on W-K-M VALVES

POSITIVE LEVERLOCK OPERATION



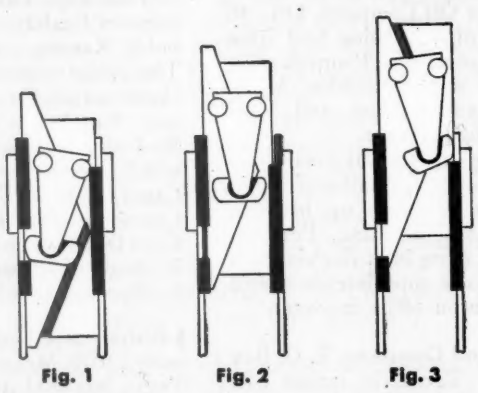


Fig. 1 Fig. 2 Fig. 3

The Leverlock Assembly is a mechanical device which positively holds the gate and segment in neutral position while the valve is being opened or closed, and permits expansion of the gate assembly at the proper time for seating in opened or closed position. A pin in the gate and one in the gate segment are linked together by means of the Leverlock arm. Guides or rails, integral with the seat skirts, provide for the proper movement of the Leverlock arm and shoe as well as guide the vertical travel of the gate assembly. Fig. 1 shows the gate and gate segment in closed position. When the valve is opened, the Leverlock arm swings to the right and travels between the guides on the seat skirt (shown in heavy black). As the Leverlock arm cannot swing to the right or left, it holds the gate and segment in neutral position positively, see Fig. 2. As the gate and segment reach the open position, the Leverlock arm swings into a slot provided on the seat skirt, see Fig. 3, thus permitting the gate and segment to expand against the seats. Clearances are shown in red on drawings above.

The Leverlock feature provides sure control over the gate and segment so that they expand only in open and closed position and remain in neutral while the valve is being operated.

Leverlock operation combined with the basic W-K-M Through-Conduit, expanding gate design provides a pipeline valve whose performance is unequalled in the most extreme service. Sure lever-action expansion guarantees that W-K-M Valves will always open or close freely regardless of service conditions. Leverlock Operation and other advantages such as vapor-tight seal against both seats, the ability to maintain and overhaul on the line, no-surge operation, and full through-conduit design assure the user of getting far more in valve performance for his money when his specs read, "W-K-M Valves All the Way."

W-K-M Valves

W-K-M COMPANY
P. O. Box 2117
HOUSTON 1, TEXAS
727 W Seventh St , Los Angeles, Calif.
EXPORT OFFICE: 30 Rockefeller Plaza, New York, N. Y.

MOST OF THE WORLD'S NEWEST PIPELINES ARE TIED TOGETHER WITH W-K-M VALVES

Houston Contracting Corporation, 2707 Ferndale Place, Houston, Texas, has the following construction work under contract:

Approximately 220 miles of 22-in. crude oil pipe line for The Texas Pipe Line Company from the vicinity of Houma, Louisiana, to Port Arthur, Texas. This work is being handled by three spreads.

One spread will lay 67 miles of 22-in. from vicinity of Holmwood, Louisiana, west to Port Arthur, Texas. E. C. Norris, superintendent; R. E. Thornton, assistant superintendent; R. J. Axsom, field office manager; headquarters, Lake Charles, Louisiana.

A second spread will have 67 miles of 22-in. from vicinity of Holmwood, east to Gueydan, Louisiana, and from Morgan City, Louisiana, east to Houma. W. H. Hayes, superintendent; M. L. Thompson, assistant superintendent; J. C. Strickler, field office manager; headquarters, Jennings, Louisiana.

The third spread will lay 86 miles of 22-in. from vicinity of Gueydan, east to Morgan City. F. A. Silar, superintendent; C. V. Oliver, assistant superintendent; L. F. Redfearn, field office manager; headquarters, Abbeville, Louisiana.

Approximately 95 miles, consisting of 30 miles of 12-in. and 65 miles of 6, 8, and 10-in. crude oil pipe lines for The Texas Pipe Line Company from Houma, Louisiana, south to and through the Terrebonne Bay vicinity. H. L. Leake, superintendent; S. B. Harrison, assistant superintendent; H. C. MacWhinnie, field office manager; headquarters, Houma, Louisiana. Underway.

Five major river crossings for The Texas Pipe Line Company from the vicinity of Morgan City, Louisiana, west to Orange, Texas. J. A. Cantrell, superintendent; J. B. Stoddard, field office manager; headquarters, Morgan City, Louisiana. Work has begun.

Modern Welding Company, Box 573, Owensboro, Kentucky, is again at work, after being shut down for a time, on a complete city gas system for Gallatin, Tennessee. A total of 40 miles of ¾-in. through 10-in. pipe will be laid. Billy Spencer is in charge of the work.

J. L. Cox and Son, Raytown, Missouri, are stringing 280 miles of 24-in. between Wood River and Kenmoor on the Platte Pipe Line Company system. J. R. Lyerla is foreman. The job is about half completed. On Sinclair Pipe Line Company's new system 150 miles of 24-in. is being strung from Cushing, Oklahoma, to Chanute, Kansas. This job also is about half completed.

H. B. Zachry Company, 1100 Transit Tower, San Antonio, Texas, began work March 5 on 24 miles of 30-in. for Texas Eastern Transmission Corporation, extending from Moorehead, Kentucky. D. B. Shrum is superintendent and Ray Shields office manager.

River Construction Corporation, 6100 Camp Bowie Boulevard, Fort Worth, Texas, has the following in progress:

Spread No. 1. Laying 30-in. pipe from the Pearl River, 26 miles south of Jackson, Mississippi. Red Tatom, superintendent. Office, Jackson, Mississippi.

Spread No. 2. Laying 30-in. pipe from Kosciusko, south. Jimmy Reid, superintendent. Office, Kosciusko, Mississippi.

Spread No. 3. Laying 26-in. pipe from Sterling Station to Perryville. Merle Tatom, superintendent. Office, Monroe, Louisiana.

Spread No. 4. Installing Pearl River crossing, north of Jackson, Mississippi. Charlie Simmons, spreadman.

The above spreads are on the approximate 1000 miles of additions to the existing facilities of the United Gas Pipe Line system in Texas, Louisiana, and Mississippi.

Spread No. 5. Installing Trinity River crossing on the 20-in. line from Orange to Port Neches. Banty Traweek, superintendent.

Spread No. 6. Laying 20-in. pipe from Fannett toward Houston. Borger Red McMenamy, spreadman.

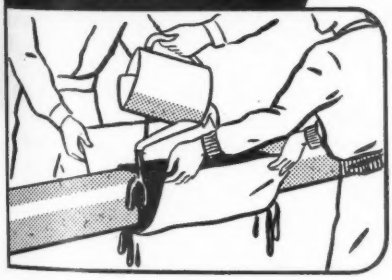
Spreads No. 5 and 6 are under the general supervision of Barney Hall with offices at Liberty, Texas, and are on the United Gas Pipe Line 97 mile, 20, 24, and 26-in. line from Orange to Houston.

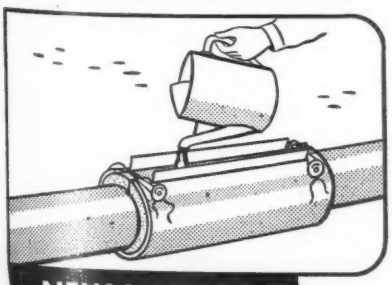
Jake Minyard is the general superintendent with headquarters at Fort Worth. P. O. Box 9127, phone Sunset 6518, office and Sunset 2104, warehouse.

PAT. APPLIED FOR

Slip on-Pour full-Lower in

OLD METHOD





NEW METHOD

INSTRUCTIONS:

1. Wrap "Field-Jointer" around pipe at the weld.
2. Pull string over top of pipe looping it around the opposite button, then return to original position. Be sure to pull string tight before fastening to avoid waste of material.
3. Pour coating material (must be hot) on top of pipe until "Field-Jointer" is full.
4. Allow to cool momentarily and lower-in.

"Field-Jointer" construction features heavy, rigid, paper mould equipped with felt inserts for each end, preventing waste, plus heavy button and string fasteners. One-quarter inch spacing between pipe and mould gives positive assurance of protection. Slip on—Pour full—Lower in.

- ★ Eliminates waste of material
- ★ Eliminates clean-up operations
- ★ Operates simply requiring no skilled labor
- ★ Affords positive proof of pipe-bottom protection
- ★ Prices and additional information, plus arrangements for field demonstrations furnished on request.

AMERICAN COATING SUPPLY COMPANY

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Box 3085—Whittier Station—Tulsa, Okla.

Pipe Line Contractors

Parkhill Truck Company, P. O. Box 1856, Tulsa, Oklahoma, announces the following work in progress:

94 miles of 20, 24, and 26-in. for United Gas Pipe Line Company; Contractor, River Construction Corporation, from Port Neches to Houston, Texas. R. M. Hiser, foreman.

150 miles of 30-in. for Texas Eastern Transmission Corporation from Wheelersburg, Ohio, to Powhatan Point, Ohio, and 66 miles from Uniontown, Pennsylvania, to Moundsville, West Virginia. Contractor, Anderson Brothers Corporation. Foremen, Ray Herron and Jimmie Stubblefield.

125 miles of 30-in. for United Gas Pipe Line Company; contractor, River Construction Corporation, from Louisiana-Mississippi state line to North Crossing of the Pearl River near Jackson. Foreman, Charles Sampson.

36 miles of 30-in. for United Gas Pipe Line Company; contractor, River Construction Corporation, from North Crossing of Pearl River to Kosciusko, Mississippi. Foreman, O. C. York.

280 miles unloading Shell Pipe Line Corporation's 14-in. pipe from Wood River, Illinois, to East Chicago, Indiana.

41 miles of 10-in. for Phillips Pipe Line Company, Harrisonville and Louisburg loops in Missouri. Contractor, Smith-Donaho Contracting Company. Foreman, John Greer.

Rumsey Brothers Pipe Line Construction Company, 4039 North Boulevard, Wichita, Kansas, was scheduled to receive pipe on the Platte Pipe Line Company job in March but it was diverted to Fulton and Brodie. Rumsey has the contract for 100 miles of 20-in. from the Nebraska-Kansas state line near Lanham, Kansas, to the Missouri River near Doniphan, Missouri.

Mahoney Contracting Company, 2300 North Grand Avenue, Lansing, Michigan, was scheduled to begin work April 1, after being shut down for the winter, on approximately 95 miles of 8-in. through 24-in. for the Michigan Gas Storage Company. The job was about half completed when closed down. The line is from Laingsburg to Mt. Clemens, Michigan. The field office is at Rochester, with Barney Finnerty superintendent and Al McConnell office manager.

Decision Filed Allocating Texas Eastern Gas

Federal Power Commission Examiner Marvin Farrington has filed a decision, subject to review by the commission, allocating or reserving to 20 corporations and municipalities a total of 28,081,000 cu ft of natural gas a day from the presently unallocated and unsold delivery capacity that Texas Eastern Transmission Corporation, of Shreveport, Louisiana, estimates will be available upon completion of an expansion program authorized by the FPC on February 27, 1951.

The examiner directed Texas Eastern after providing for the requirements of these 20 and its other authorized customers, to devote all remaining unallocated volumes of gas to the development and operation of the Oakford Storage Field. The FPC's February, 1951, order left unallocated and unsold approximately 91,882,000 cu ft of gas per day out of the 465,700,000 cu ft increase, which was authorized at that time, bringing Texas Eastern's total authorized system capacity to 1,206,500,000 cu ft daily.

The examiner's decision is on an application in which Texas Eastern is seeking authority to dispose of 107,606,000 cu ft of the 116,579,000 cu ft that it estimates will be available from the joint operation of its presently authorized system plus the gas to become available when the storage project is completed.

The Oakford project is being developed jointly by Texas Eastern and New York State Natural Gas Corporation, of New York City, in Westmoreland County, Pennsylvania. The field cannot be fully utilized until the entire 45 billion cu ft of base storage gas is in place expected in 1954. However, Texas Eastern will have to maintain for full operation about 30 billion cu ft of top storage gas, from which withdrawals will be made, and under its present proposal only 24 billion cu ft of this active gas can be built up by 1957.

ROSKOTE cold-applied anti-corrosion mastic saves time...saves money...SAVES PIPE!

Roskote's drying speed, its handling ease and its high electrical resistivity makes it the ideal mastic for pipeline protection, winter or summer. Whether you are protecting distribution and service lines, or large transmission lines in yard or field, it will pay you to investigate . . .

ROSKOTE cuts field costs because it is applied COLD — either brush, spray or special line-traveling machine — without primer or field mixing. It eliminates labor, equipment and hazards of hot-applied materials. It is fast-setting to a tough, flexible film of high electrical resistivity (20 megohms per sq. ft.) without brittleness or sag through a temperature range of −40° to 375°F. It dries to the touch in 20 minutes and is ready for backfill in an hour.

Roskote's resin base resists acids, alkalies, salts and moisture. It bonds readily to previous coatings of coal tar or asphalt. Wire brushing is the only preparation needed for old pipe.

Roskote's drying speed and handling ease cuts man-hours from work schedules and speeds pipe-line progress. That saves real money! Yet Roskote costs only 3¢ per square foot of coverage.

Used by over 70 utilities and pipeline companies for coating at "hot spots," road crossings, for valves, joints, meters, drips; for patching and for waterproofing concrete regulator pits.

•

Write for bulletin containing complete technical specifications, chemical and electrical properties and application information. Ask for the Roskote special trial order offer.

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LABORATORIES, INC.,
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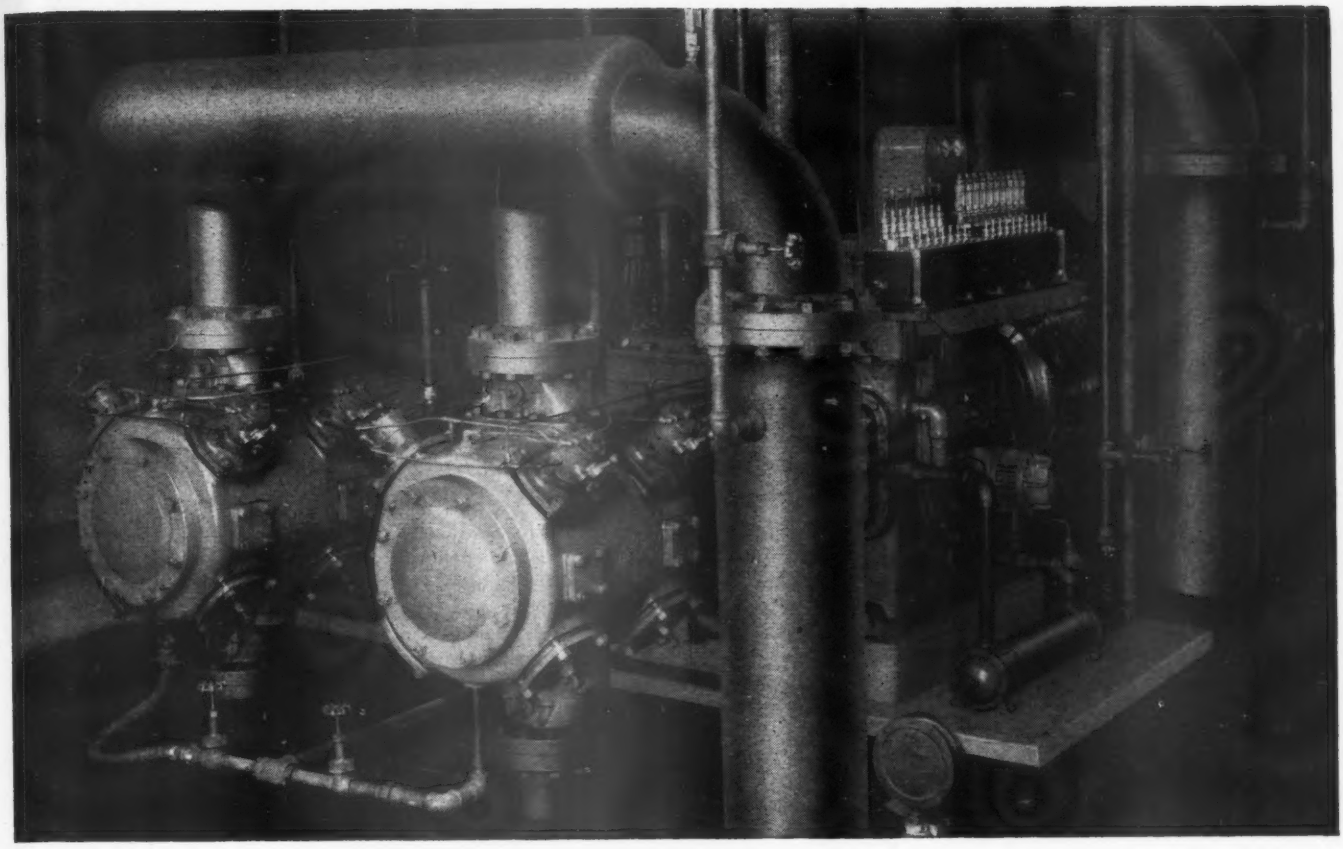
MANUFACTURERS OF QUALITY INDUSTRIAL COATINGS RESISTANT TO CORROSION BY ACIDS, ALKALIES, ELECTROLYSIS, HEAT, MOISTURE AND WEATHER.



SAVINGS... even before the word GO!

Great Lakes Refining selects the compressors that simplify erection and firewall installation

When Great Lakes Refining Co. was planning its new Houdriflow cat cracking unit at Blue Island, Illinois, one of the prime requirements was a low fire hazard compressor installation for vapor recovery service.

What type of compressor should be used? The decision was easy after Clark engineers made a thorough analysis carefully considering gas and steam engine driven units, motor driven reciprocating units and centrifugal compressors. Building all types of compressors, Clark was unusually qualified to make this comparison—*impartially!* Recommendation: Two Clark CMA-4, 300 bhp, Balanced/Opposed, Synchronous Motor Driven Compressors.

Of major importance was adaptability to firewall type construction. Having a single unit crankcase with the driving motor on the end, it would be a simple matter to isolate the motor from the Clark Balanced/Opposed Compressor. The shaft would merely extend through the firewall, with a simple packing gland sealing out the gas.

Costwise, Great Lakes Refining was ahead from the day the order was placed. Considerable time and cost in installation were saved by shipping the unit completely assembled. Vibration-free operation —*the result of perfect balance*— paid off in smaller foundation cost and will *continue* to pay off in practically maintenance-free operation.

For details on this truly modern compressor, write for Bulletin No. 118. For complete information on *all* your compressor problems, call in the nearest Clark representative for an unbiased answer.

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balanced/opposed COMPRESSORS

NEWS

OPS Rejects Price Plea

The plea for higher prices on oil and gas filed by the Independent Petroleum Association has been rejected by the Office of Price Stabilization. This action was not regarded as dismissal of the case. Plea was rejected on two technical points: (1) trade associations have no authority to ask for relief before OPS, and (2) the "protest" was not filed within six months after oil and gas price orders were issued.

If put into effect, the requested price hike of 72 cents a barrel, would bring crude oil to a national level of $3.28 per barrel against the present average of $2.56. IPAA also said that a 42-cent increase is needed to carry out this year's program of 50,000 new wells.

IPAA has requested that both crude petroleum and natural gas be freed of all price controls.

Russell B. Brown, general counsel of the association, filed the brief with the Office of Stabilization explaining that major basis for price control do not exist in the oil industry. These are runaway prices and shortage of product or possibilities.

Brown urged that Congress make mandatory the exemption clause in the present Defense Production Act, whereby the President has authority to exempt commodities from price control whenever such action is necessary to promote national defense, or price controls are unnecessary.

He emphasized, "This matter is of such importance to the defense effort it should not be left to the discretion of the agency concerned only with price-control authority."

Imports Down Slightly

Total imports for the week ended March 8 were 856,300 with the total for the four weeks period ended that date reaching 898,300 bbl per day, according to the American Petroleum Institute. This was a slight decrease from the week ending March 1, which reached a total of 945,900 bbl per day.

Week ended	Crude oil	Residual oil	Others	Total
	(Figures in bbl per day)			
February 16.....	381,300	473,500	24,900	879,700
February 23.....	475,500	407,500	28,400	911,400
March 1.....	541,200	392,100	12,600	945,900
March 8.....	436,000	383,600	36,700	856,300
4 weeks average..	458,500	414,200	25,600	898,300

Peruvian Oil Law Signed

A new Peruvian oil law has been signed, opening the country's oil deposits to foreign companies under 50-50 profit-sharing between the companies and the government. In a speech broadcast to the country's people, President Manuel Odria stated that Peru does not have enough state or private capital to exploit the oil itself, and also lacks technical experts for the work. He added that a government agency will supervise the accounts of these concessionaries.

Bermudez Dallas Press Conference: Standing: Manuel Colsa, *Frontera*, Mexico, D. F.; Javier Escobar, Vice Consul of Mexico, Dallas; Jose Chapa, *Hoy Magazine*; Manuel Rodrigues Aguilar. Seated; Alfonso Barnetche, manager of production, Petroleos Mexicanos (Pemex); Jose Colomo, assistant to Bermudez, Senator Antonio J. Bermudez, director general of Pemex; John B. O'Connor, host and executive vice president, Dresser Industries, Inc., Dallas; Ignacio Pesquiera, Mexican Consul, Dallas, and Virgilio Garza, Gas Industrial de Monterrey, Mexico, D. F.

H. N. Mallon, president, Dresser Industries, Inc., Dallas, Texas and Gardiner Symonds, president, Tennessee Gas Transmission, Houston.

Scientific Group Set Up

The first branch of the Scientific Research Society of America between Pennsylvania and the Pacific Coast was established in Texas in recognition of work of Southwest Research Institute.

Dr. George A. Baitsell, editor-in-chief of publications for the American Association for the Advancement of Science and professor of biology at Yale University, presided over the installation of officers recently for the Southwest Research Institute branch of RESA.

Dr. William V. Houston, president of the Rice Institute in Houston and a trustee of SwRI, was principal speaker at a dinner in the St. Anthony Hotel preceding installation of Dr. Charles A. Culver, an authority on electroacoustics and dean of professional development at SwRI, as first president of the branch.

Other officers are Dr. John Loefer, research biologist of the Southwest Foundation for Researeh and Education, vice president; Dr. John C. Cook, SwRI physicist, secretary, and Fred Koebel, SwRI mechanical engineer, treasurer.

Mexico's Bermudez Guest Of Dresser Industries

Senator Antonio J. Bermudez, director general of Petroleos Mexicanos (Pemex), Mexico's government-owned oil organization, was the guest of John B. O'Connor, executive vice president of Dresser Industries, Inc., in Dallas, Texas, recently. O'Connor, as a close personal friend of Bermudez, arranged the affair in his honor to pay tribute to the Senator and at the same time have the leading oil men of the U. S. meet Bermudez.

Speaking to some 600 oilmen in Dallas at a luncheon held in his honor, Bermudez stated that Pemex drilled 267 wells in 1951 and hopes to drill 400 this year. Of these, roughly 30 per cent are wildcats and 40 per cent are drilled by independent contractors. He told a press conference after the luncheon that Pemex only had definite commitments for enough steel to drill 120 wells during 1952's first half. He added that if he could get enough steel, he would like to drill 500 or more wells this year. Pemex has 111 drilling rigs, he said, and not one sits idle. They are moved from job to job.

PAD Asks for More Steel

Unverified rumors has been persistantly repeated that the oil and gas industry will get a substantial increase in steel for the third quarter of 1952. PAD has asked that allocations of steel be increased 46 per cent in the last half of 1952 over the average rate of the last four quarters. For Canadian export, a 42 per cent increase is sought on the same basis; for shipment to other producing areas outside the Iron Curtain, a 34 per cent increase is requested. PAD itself holds little hopes for fulfillment of this request.

A total of 53,350 tons of oil-industry tubular goods were delivered to oil and gas operators during the last three quarters of 1951.

PIEA Completing Annual Meeting Arrangements

With about 700 oil industry experts in electrical communications expected to attend, plans for the 24th annual meeting of the Petroleum Industry Electrical Association and the Petroleum Electric Supply Association in Tulsa, Oklahoma, April 14-17 are complete.

Pat O'Connor, Service Pipe Line Company, chairman of the publicity committee, said the meeting "is shaping up as one of the best the associations have ever had." He announced two changes in the previously distributed program for the meeting.

R. J. Osborn and Glen Ladd, Sinclair Pipe Line Company, Independence, Kansas, will discuss "Application of Equipment Designed for Hazardous Areas in Petroleum Industry."

Radio Corporation of America will discuss "Tone Coding—Directional Antennae—Industrial Television Application."

The four-day program covering many phases of the use of electricity in the oil and gas industries will be held in Tulsa's Mayo hotel and Cimarron Ballroom. All exhibits will be set up in the ballroom, O'Connor said.

M. C. Callahan, Gulf Refining Company, Tulsa, is the general chairman. He announced the conferences would start at 10 a.m. April 14 with a meeting of the board of directors of the PIEA at the Mayo.

Fell Warns U.S. Oil Must Be Free to Meet Demands

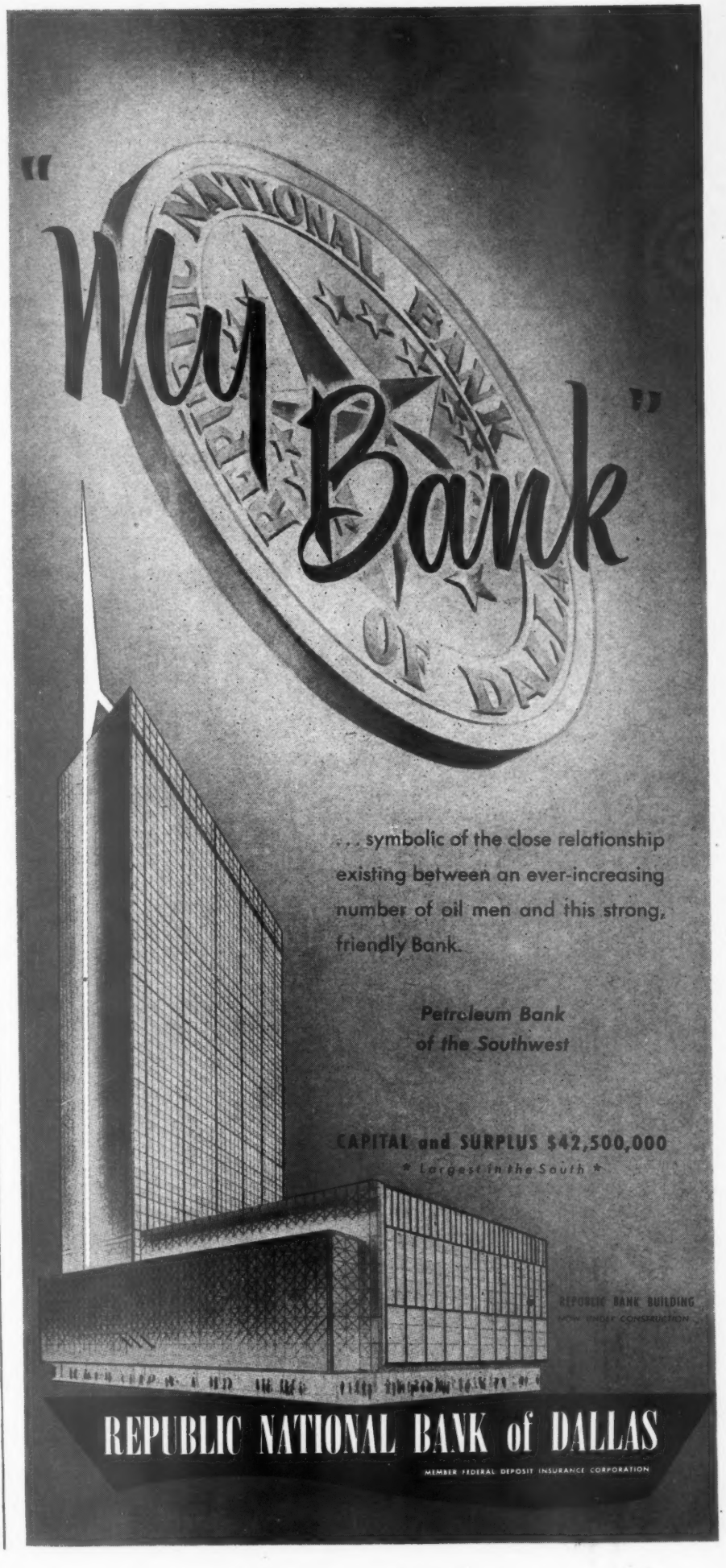
The oil and gas industry cannot continue to meet the nation's fuel requirements under unnecessary government controls "administered by human beings," an official of the Independent Petroleum Association of America declared recently. H. B. Fell, executive vice president of IPAA, in a speech prepared for a Petroleum Engineering-Management conference at the University of Oklahoma, declared that:

"Under government controls, human beings substitute their judgment for the natural laws in setting both prices and wages, with the result that administration of both are subject to pressure from groups wielding the greatest influence."

He added that "the only period in the history of the domestic petroleum industry when it did not make progress was under the period of federal controls in World War II."

He said the industry's inability to expand its producing capacity during the war was due to the freezing of crude oil prices at inadequate levels, insufficient materials and trained manpower, and "particularly the creeping paralysis that comes from centralized controls."

Pointing out that oil and natural gas now supply about 58 per cent of the nation's energy requirements, as compared to 7.9 per cent 50 years ago, Fell warned that petroleum demand is still rapidly increasing "and can be filled only by a free operating industry."


"My Bank"
. . . symbolic of the close relationship existing between an ever-increasing number of oil men and this strong, friendly Bank.
Petroleum Bank of the Southwest
CAPITAL and SURPLUS $42,500,000
* Largest in the South *
REPUBLIC BANK BUILDING
NOW UNDER CONSTRUCTION
REPUBLIC NATIONAL BANK of DALLAS
MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Operator places his hands on victim's back so that the thumbs just touch and heels of the hands are just below a line running between the armpits.

He then rocks forward slowly, keeping the elbows straight, until his arms are approximately vertical, exerting steady pressure upon chest.

Then he rocks backward, slowly sliding his hands to the victim's arms just above the elbows.

Elbows are raised until resistance is felt at victim's shoulders by the rescuer—then the arms are dropped.

Artificial Respiration

Correct positions for the back pressure-arm lift method of artificial respiration, recently adopted by the American National Red Cross upon recommendation of the National Research Council, are illustrated in the accompanying picture. In this method the victim is placed prone with the elbows bent and with one hand on the other. The cheek is placed on the hand, with the face turned slightly to one side. The operator kneels on one knee at head of victim.

Rescuer, on one or both knees at victim's head, places his hands on the victim's back, with thumbs just touching and the heels of the hands just below a line running between the victim's armpits. The rescuer rocks forward slowly, elbows straight, until his arms are almost vertical—exerting steady pressure upon the back. Next, the rescuer rocks backward slowly and slides his hands to the victim's arms, just above the elbows, which are raised until resistance is felt at the victim's shoulders—then, the arms are dropped. This completes a full cycle, repeated 12 times a minute.

Oil Film Library Set Up

A special film library on petroleum subjects will be collected by the University of Texas Visual Instruction Bureau, Director Ernest Tiemann announced. A catalog will be prepared and issued to the oil industry following a survey now in progress.

Annual Statistical Article To Appear in May Issue

Facts indicate that oil is becoming harder to find each year, and involves expenditures that are made possible only through adequate financial returns on invested capital and the compensatory provisions of the depletion allowance, according to H. J. Struth, petroleum economist.

Statistics to support his conjectures are given in an article, "Record Expenditures Bolster Nation's Oil Reserves," which will appear in the May issue of *The Petroleum Engineer*.

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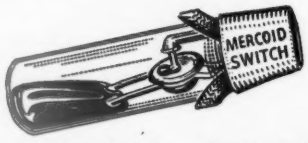
Like the proverbial expression, "A Chain Is No Stronger Than Its Weakest Link," likewise, "A Control Is No Better Than Its Electrical Contacting Mechanism."

Where open contacts are used, they are exposed to dust, dirt and corrosion, and arc in the open, causing pitting and sticking of the contacting surfaces.



The Mercury Switch used exclusively in all Mercoid Controls is protected from the above handicaps, and operates indefinitely without any deterioration, thereby assuring that added safety and better performance.

If you have a control problem—involving the automatic control of pressure, temperature, liquid level, mechanical operations, etc.; it will pay you to consult Mercoid's engineering staff—always at your service.

WRITE FOR CATALOG 700-A. PLEASE MENTION THIS PUBLICATION

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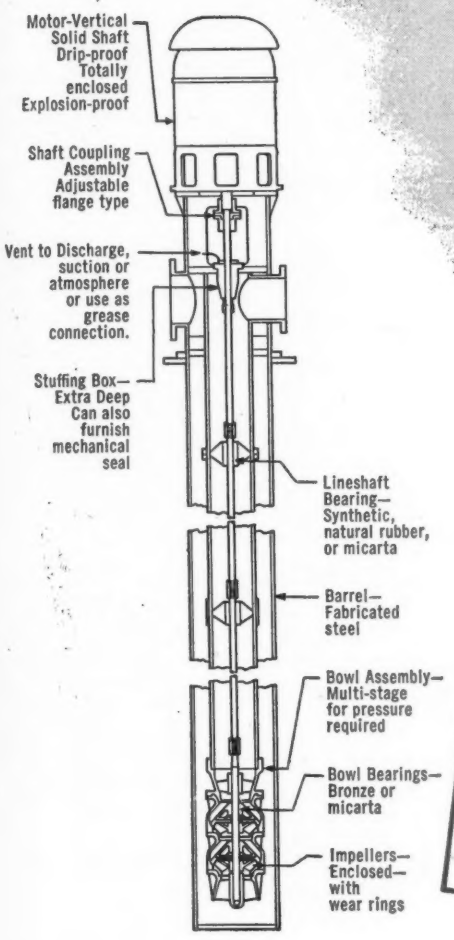
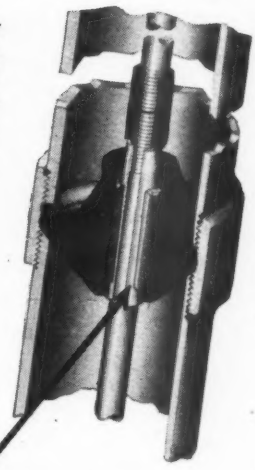
NOTES FROM THE PUMP ENGINEER'S HANDBOOK


Motor-Vertical Solid Shaft Drip-proof Totally enclosed Explosion-proof
Shaft Coupling Assembly Adjustable flange type
Vent to Discharge, suction or atmosphere or use as grease connection.
Stuffing Box—Extra Deep Can also furnish mechanical seal
Lineshaft Bearing—Synthetic, natural rubber, or micarta
Barrel—Fabricated steel
Bowl Assembly—Multi-stage for pressure required
Bowl Bearings—Bronze or micarta
Impellers—Enclosed—with wear rings

This unit is a vertical turbine type pump designed to handle volatile liquids and liquids near the boiling point. Both suction and discharge are above grade and the pump bowls are enclosed in a steel barrel. This pump offers many advantages where there is a limited NPSH... Bowls are easily set low enough for proper submergence ... Expensive dry sumps are eliminated... Nothing to lubricate except driver bearing ... Efficiency is comparable with horizontal centrifugals at low heads and is often greater at high heads.

SHAFT WEAR CAN'T HAPPEN to a Johnston Water-Lubricated Pump!

Here's another QUALITY feature that makes Johnston Water-Lubricated Turbine Pumps a good investment. The renewable stainless steel sleeves which shroud the line-shaft at all points of bearing contact make it impossible for sand or other abrasives to damage the shaft. Sure, the sleeve and bearings wear on a Johnston just like they do on any pump ... but think of the savings on parts and labor alone when you simply replace a sleeve instead of a complete section of shafting. What's more, you don't need a lot of special tools to do the job! Do it at the pump site ... just unscrew the old sleeve and thread on the new!!!



LITTLE DETAILS LIKE THE RENEWABLE SHAFT SLEEVE MAKE JOHNSTON PUMPS BETTER!!!

Trained hydraulic engineers are available at your nearest Johnston Dealer or at the Johnston factory to furnish detailed information, proposals and anything else necessary to meet your particular pumping equipment needs.

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Sizes range from 4 to 32 inches; single- or multi-stage; 2 to 1000 H.P.; capacities to 10,000 G.P.M.; lifts to 1000 feet; for liquid temperatures to 400° F.

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Why Most Pipe Fitters Buy RIDGID Pipe Wrenches

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★ It's an extra fast easy wrench to work with, too—handy pipe scale on hookjaw, adjusting nut spins easily to pipe size, comfort-grip handle.

★ Special alloy jaws both replaceable—won't slip or lock on pipe.

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★ Save money, make work easier—buy RIDGID, world's most popular pipe wrench, at your Supply House.

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★★★ RIDGID Work-Saver Pipe Tools ★★★

September World Oil Declines from August

In September, world crude petroleum production averaged 11,704,000 bbl daily, a decrease of 9000 bbl daily from August, the U. S. Bureau of Mines has reported. Kuwait's daily average production decreased 61,000 bbl, and Canada's production declined 7000 bbl. Daily average production in the United States increased 29,000 bbl; Venezuela 16,000 bbl; Saudi Arabia 9000 bbl; and Indonesia 5000 bbl. During the quarter ending September 30, world crude production averaged 11,692,000 bbl daily compared with 11,619,000 during the first half of the year. Crude petroleum production during the first nine months averaged 11,644,000 bbl daily, an increase of 15 per cent over the same period in 1950.

Western Europe's daily imports of crude petroleum decreased 53,000 bbl from August to 1,149,00. The major importing countries in barrels daily were: United Kingdom, 388,000 (August 415,000); France, 351,000 (410,000); Netherlands, 134,000 (108,000); Italy and Trieste, 149,000 (152,000); and Western Germany, 79,000 (59,000). United Kingdom crude petroleum imports for the first nine months of 1951 were 69 per cent higher than in the comparable period last year.

API Film Available

"Microscopic Behavior of Fluids in Porous Matrices" is the title of a new Kodachrome sound film just released by the American Petroleum Institute's Project 47B. The film is a microscopic study of the behavior of immiscible liquids in synthetic flow beds. The underlying purpose of this research is the uncovering of micromechanisms of fluid flow in porous media.

Water-wet and oil-wet flow beds have been used in these studies. The fluid systems consisted generally of crude oil and water or brine. Instances of simultaneous flow as well as displacement phenomena have been included. To a small extent air has been considered as a third fluid phase. Flow structures, residual fluid formations, and flood front patterns have been examined.

Running time for the film, which is available in 16 millimeter, is about 28 minutes. It may be obtained from E. O. Mattocks, American Petroleum Institute, 50 West 50th Street, New York 20, New York.

PAD Export Figures Out

The Petroleum Administration for Defense has published weekly summaries of United States exports of major petroleum products. Figures in table include barge and tanker movements only, and are in thousands of barrels daily.

Week ending	Avgas*	Motor gasoline	Kerosine	Distillate	Residual	Total
Jan. 18....	63.3	3.2	64.8	64.2	31.3	226.8
Jan. 25....	29.2	40.1	14.6	74.6	40.3	198.8
Feb. 1....	65.4	0.1	—	63.9	44.3	173.7
Feb. 8....	26.7	24.5	—	34.5	80.6	156.9
Feb. 15...	15.4	28.0	4.9	71.4	69.9	189.6

Extra WORK CAPACITY

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25-TON 304 CRANE

Reserve strength and operating stability of Koehring 304 Crane gives 13.9-ton lift and boom lengths up to 75 feet on crawler mounting . . . 25-ton lift capacity and maximum reach up to 110 feet (including jib) on rubber-tired truck or cruiser mounting.

It's readily converted to dragline, clamshell, ¾-yard shovel or hoe. With every attachment, big 304 booster clutch reduces normal lever pull 50%, yet retains accurate "feel" of load. Heat compensator spring makes tension changes automatically, maintains full clutch efficiency at all times.

For all the facts, see your Koehring distributor, or write for new 304 catalog.

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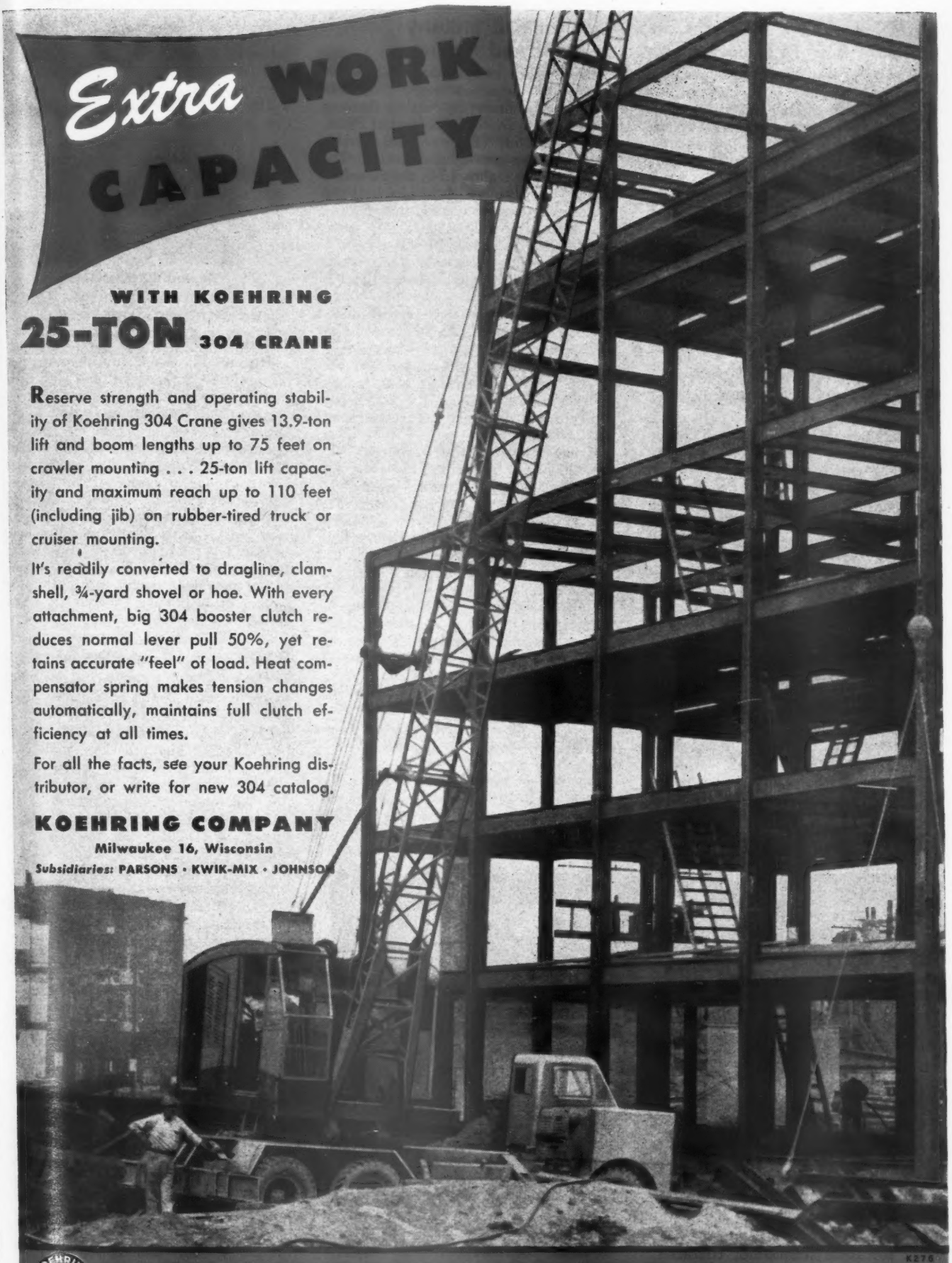

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KOEHRING *heavy-duty* CRANES

7¾ to 79½ TONS lift capacities . . . EXCAVATORS ½ to 2½ yards

Oil Demand Up 13 Per Cent In 1951, B of M Reports

The Bureau of Mines has reported a 12.9 per cent increase in demand and a 13.7 per cent production during 1951. Oil production averaged 6,149,000 bbl daily during 1951, with domestic demand for oil averaging 6,121,000 bbl daily, and oil runs to refineries averaging 6,494,000 bbl daily. Oil runs were up 13.2 per cent over 1950. The Bureau also reported that imports of foreign oil, not including residual fuel oil and other products, averaged 491,000 bbl daily in 1951, a gain of less than 1 per cent over 1950. U. S. oil exports averaged 79,000 bbl daily, a decline of 17 per cent.

Oil Needs Trained Men, Porter Tells Conference

The oil industry has not only made extensive use of trained technical men but also has a growing need for more and more men of specialized skills and talents, Frank M. Porter, president of the American Petroleum Institute, declared at a Petroleum Engineering Management Conference sponsored by University of Oklahoma. He described the trained technical man as a "modern pioneer (who) finds the new continents, clears the new lands, and leaves them for others to develop."

He outlined the qualifications that a sound technical man should possess, and asserted:

"The man who exhibits these qualities is quickly recognized in any organization, but the need for him exists in the petroleum industry to a much greater degree than in most.

"The oil industry already has a great many men of this type, but the market is never saturated. As the industry grows and expands, so does the need for men with special skills and aptitudes."

Mexican Oil Industry Sees Marked Progress

Progress in every phase of Mexican petroleum operations was reported in a five-year summary by Senator Antonio J. Bermudez, Director General of Petroleos Mexicanos (Pemex), the Government oil and gas administration. The summary was embraced in the Senator's annual report, in which he also outlined a program of new installations calling for expenditures of 450,000,000 pesos (more than $52,000,000).

In reviewing Mexico's gains since 1946, Senator Bermudez listed the following:

Crude oil reserves—up from 1,058,000,000 bbl to 1,424,000,000 bbl. Adding to this the natural gas reserves, with a calorific equivalent of 363,000,000 bbl of crude oil; and adding, also, the 8,860,000 bbl of distillate, the nation has total proved hydrocarbon reserves of 1,795,860,000 bbl.

Crude oil production—up from 49,239,800 bbl to 78,780,387 bbl.

Drilling—total footage drilled in 1951 was the greatest for any year since 1927, amounting to 1,095,595 ft (334,023 meters). The number of wells drilled was 268, compared with 64 in 1947.

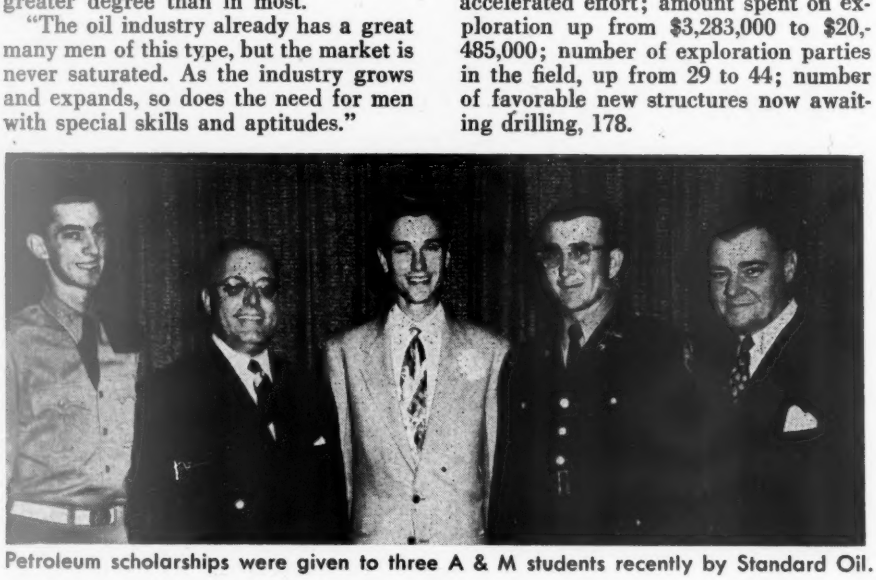
Refinery output—up from 42,300,000 bbl to 56,780,000 bbl.

Income — up from $65,891,000 to $212,554,000.

Products distributed by Pemex in Mexico—Up from 33,500,000 bbl to 50,550,000 bbl.

Exports—up from 9,740,000 bbl to 22,393,622 bbl.

Exploration activity — Twenty-four new fields discovered in consequence of accelerated effort; amount spent on exploration up from $3,283,000 to $20,485,000; number of exploration parties in the field, up from 29 to 44; number of favorable new structures now awaiting drilling, 178.



Petroleum scholarships were given to three A & M students recently by Standard Oil.

A & M Students Awarded

Three senior petroleum scholarships were presented Texas A. and M. students for their leadership, character, good citizenship, and outstanding scholastic achievements. The awards were made by Standard Oil Company of Texas and Magnolia Petroleum Company. Speaker of the occasion was E. O. Buck, vice president of the National Bank of Commerce of Houston. In accompanying photo are: W. M. Sargent, Fort Worth; John Domercq, Jr., vice president, Standard Oil Texas; Julian C. Herring, Abilene; Baxter D. Honeycutt, Pickton, and D. V. Carter, chief petroleum engineer, Magnolia Petroleum. Sargent, Honeycutt, and Herring, the winners, are senior petroleum engineering students.

Robert F. Windfohr

Windfohr Demands End Of Oil Price Controls

Robert F. Windfohr, president of Texas Mid-Continent Oil and Gas Association, urged an end to price controls of petroleum products in Dallas, Texas, recently. Speaking before oil and gas operators from Central and North Central Texas, Windfohr cited crude price fixing as an "example of big government control for the sake of control and not because of the need." He indicated that today's price for crude oil should be $3.22 per barrel, or 57 cents above the present scale. He reported that this would establish parity with all other commodities, based on Bureau of Labor statistics.

PAD Revises Line Pipe Form

The Petroleum Administration for Defense has announced that Form PAD-26LP has been revised. This is the form used to obtain priorities assistance in purchases of line pipe for small construction and production operations.

Main changes in the form are:

1. An operator who has received an allotment of line pipe from PAD after filing a PAD-26LP but has not been able to place his order within 30 days after the beginning of the quarter for which the allotment was authorized must notify PAD of this fact by a letter in duplicate.

2. Operators are required to report their average quarterly receipts during the preceding four quarters of all line pipe, *new and used*, for use in the operation for which they are seeking priorities assistance.

3. Operators may request on the application for advance authorization of pipe for the quarter succeeding that for which priorities assistance is first requested.

4. Boiler and still tubes are now specifically excluded from the pipe that may be obtained by use of the PAD-26LP. New definition of line pipe on the form is "seamless and welded steel and wrought iron pipe other than casing, tubing, and drill pipe (oil country tubular goods) and boiler and still tubes."

5. Separate PAD authorizations of priorities have been provided for purchases of line pipe under 16 in. diam, more than 16 in., and exactly 16 in. in diameter.

Annual Oil Reports Reveal Higher Industry Earnings

Additional annual reports from major oil companies substantiate the first earlier indications that earnings were higher in 1951 than 1950, even with a greater amount taken out for taxes, and plowed back into the industry.

Later reports are as follows:

Argo Oil Corporation. Net income of $3,534,710 was reported last year compared with $2,849,512 in 1950. The company produced 2,645,316 bbl of crude oil in 1951 compared with 2,442,062 bbl the year before.

Atlantic Refining Company. Net income reported was $45,100,000, an increase of $4,200,000 above last year. Combined net foreign and domestic crude production totaled 35,450,000 bbl, 60 per cent of refinery runs.

Bishop Oil Company. Net income for Bishop last year totaled $407,713.98, up from the $276,014.24 the year before.

Continental Oil Company. This company's net earnings were slightly under those of 1950. In 1951 they reached $41,292,692, compared with $42,406,666 last year. Net crude oil production was up—an average of 114,551 bbl daily compared with 101,029 output in 1950.

Derby Oil Company. Derby's 1951 net income amounted to $1,466,445; in 1950, $1,093,775. Net crude oil production amounted to 1,212,601, last year, and 1,097,674 the year before.

Deep Rock Oil Corporation. Net earnings for 1951 totaled $2,241,000, comparable to $2,980,000 in 1950. Deep Rock produced 2,972,000 bbl last year, approximately the same as 1950.

Lion Oil Company. Net profit for the year 1951 totaled $11,751,026 down from $13,988,245 in 1950. Crude oil production was up slightly last year—8,011,422 bbl compared with 1950's 7,854,224.

Mid-Continent Petroleum. Net income for 1951 reached $17,062,182, compared with $15,662,632 in 1950. Crude oil production remained about the same—1951 net amount 6,978,906 and 6,591,644 bbl in 1950.

Ohio Oil Company. Net income for the year 1951 totaled $41,681,663, comparable to the 1950 income of $37,349,903, an 11.6 per cent increase. Net crude oil production totaled 33,804,883, an 11.8 per cent increase from the daily average in 1950.

Panhandle Producing and Refining Company. Net profit for the company last year totaled $1,352,620, above the $1,296,221 reported in 1950. Crude oil produced in 1951 was 1,503,036 bbl, as compared with 1,431,299 bbl in 1950.

Pure Oil Company. A considerable increase from 1950 net income was shown in Pure Oil's annual report. Last year the total was $33,593,727 compared with $30,329,084 in 1950. The company's net production was 26,897,785 bbl, compared with 1950's net production figure of 25,334,661 bbl.

Richfield Oil Corporation. A net income of $28,218,281 for last year was reported by Richfield, compared with 1950 net earnings of $23,046,379. It produced 28,093,000 gross barrels of crude oil, up 22 per cent from 1950.

Shell Oil Company. Net income for 1951 was $97,020,000 compared with $94,186,000 in 1950. Net crude oil production reached a new high of 236,000 bbl a day in 1951, compared with 198,000 bbl a day in 1950, and a previous production record of 215,000 bbl a day in 1948.

Skelly Oil Company. Net income for Skelly amounted to $31,074,985, compared with $28,514,066 in 1950. Net crude oil production reached a new record for the company, 23,267,153 bbl, compared with 20,056,439 in 1950.

Socony-Vacuum Oil Company, Inc. The company's net income reported for 1951 was $161,622,159. Its 1950 income amounted to $128,216,000. Domestic and foreign crude oil production totaled 138,370,000 bbl, compared with 113,325,000 bbl of oil, produced the year before.

Standard Oil (Indiana). Total net earnings of the company reached $148,697,356, higher than any other previous year. Compared with 1950, production of crude oil and natural gas liquids was up 22 per cent.

Sunray Oil Corporation. Net earnings in 1951 amounted to $24,282,000 as compared with $20,462,000 in 1950, approximately a 20 per cent gain. Net crude production during last year totaled 26,632,469 bbl, an increase of 5 per cent above the 25,306,671 bbl during 1950.

Texas Pacific Coal and Oil Company. Net income in 1951 amounted to $6,824,124 compared to the 1950 total of $5,997,367. Crude oil produced, net, totaled 6,844,618 bbl, up from the 5,666,663 bbl produced in 1950.

Union Oil of California. Net earnings last year amounted to $27,295,971, compared to $17,177,547 reported in 1950. Crude oil production rose 18 per cent above 1950.

Wilcox Oil Company. Net earnings for 1951 amounted to $860,004, compared to $704,382 in 1950, a 22 per cent increase. Crude oil production rose slightly, with a total of 879,044 bbl, compared to 803,397 bbl produced in 1950.

Industrial Research Group Plans Annual Conference

Professor David Bendel Hertz has announced that the annual conference on Industrial Research, sponsored by the school of engineering and the center for studies of Research Administration of Columbia University, would consider the crucial problem of design of research operations during the week of June 9 to 13. Attendance at the conference, which is limited to two research executives from any one company and a total of 75, will include research administrators from a cross-section of U. S. industry, and from very small labs to some of the largest in the country.

Industrial Relations Meet

Five nationally known authorities in the field of human relations have accepted speaking assignments for the annual Southwest Area Conference on Industrial Relations, to be held May 9-10 at the Rice Hotel in Houston.

The theme of this year's conference will be "Employee-Management Progress—How?" To this theme will be geared a stimulating two-day program of talks and panels in which many industrial executives will take part.

Harold Decker, president of Houston Oil Company, will be general chairman of the conference. Assisting him will be two vice chairmen, L. R. Bryan, Jr., president of the Second National Bank of Houston, and Joseph R. Mares of Texas City, vice president of Monsanto Chemical Company.

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PERSONALS

E. L. DeGolyer, Dallas, Texas, petroleum geologist-engineer, has been presented a certificate of honorary membership in the American Institute of Mining and Metallurgical Engineers. Presentation of the award, one of the highest AIME honors, was made at a banquet held in Dallas recently. It was given DeGolyer by Michael L. Haider, New York, Institute president and Standard Oil Company of New Jersey official. DeGolyer has been a member of the AIME petroleum branch since 1914.

C. F. Beatty, a director of Socony-Vacuum Oil Company, Inc., is one of a group of business executives re-elected board members of the National Industrial Conference Board for a term of one year.

The Conference Board, founded in 1916, is a non-profit institution to gather, test, explain, and distribute facts essential to the establishing of management, labor, government and economic policies.

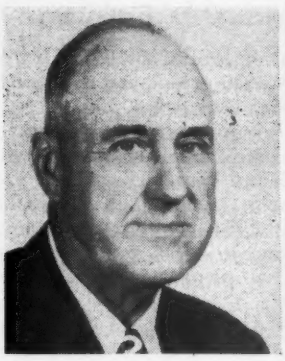
C. G. Cortelyou has been appointed chief design engineer of the General Petroleum Corporation's engineering department. In his new post Cortelyou succeeds **A. K. Brumbaugh** who has joined the refinery engineering department of the Socony-Vacuum Oil Company, Inc., of which General Petroleum is Western affiliate.

Cortelyou has been with General Petroleum since 1938, not long after his graduation from the California Institute of Technology. He advanced from laboratory work to the position of measurement engineer in 1940 and since that time has been successively job engineer and project engineer in the engineering department's Vernon, California, headquarters.

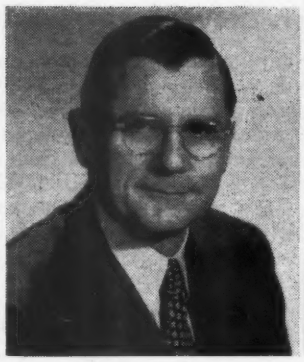
R. L. Keyes has been elected president and a member of the board of directors of the Arabian American Oil Company. Keyes has been associated with the oil industry since 1919. After doing geological work in Oklahoma, Texas, New Mexico, and Kentucky, he joined The Texas Company in 1928 as a petroleum engineer. He served in various executive capacities and last year was made assistant general manager of The Texas Company's producing department, with headquarters in Houston, Texas.

Keyes was graduated from Pomona College in 1917 with a Bachelor of Arts Degree. He later studied at the University of California and Columbia University. His headquarters will be in Dhahran, Saudi Arabia.

Richard D. Murphy has recently joined the automotive division of the Whiting research laboratories of Standard Oil Company (Indiana). Murphy is a graduate of Purdue University in mechanical engineering.



Earl A. Brown



H. N. Oldham

James C. Reid

Earl A. Brown has been elected vice president and a member of the board of directors of Magnolia Petroleum Company. He has been general counsel of Magnolia since last August.

Brown was graduated from the Law School at the University of Texas in 1914 and after practicing law for three years in Ennis and Waxahachie, moved to Tulsa, Oklahoma, where he practiced until 1920. In 1936 he joined the company's legal staff at Oklahoma City and in 1939 was transferred to Magnolia's general offices in Dallas as assistant general counsel.

Joseph A. Costello, B. Bynum Turner, and **Sanford M. Wagner** have been elected to the board of directors of Ethyl Corporation it is announced by President E. L. Shea. The three men are all vice presidents of Ethyl and in charge of operating functions within the company.

A. P. Frame, vice president of Cities Service Company in charge of manufacturing and research, has been named associate deputy administrator of the Petroleum Administration for Defense. He will be succeeded as assistant deputy administrator in charge of domestic petroleum operations by C. E. Davis, vice president of Shell Oil Company in charge of refining.

Carroll D. Fentress, special assistant to the Deputy Petroleum Administration, has been named to the new post of executive secretary of the PAD. A Massachusetts Institute of Technology graduate, Fentress was appointed to the department of the Interior oil and gas division in 1946.

J. S. Leach, of The Texas Company, New York, has been appointed chairman of the American Petroleum Institute's Study Committee on Special Projects. Leach succeeded A. Jacobsen, president of Amerada Petroleum Corporation, in the chairmanship. Other members of the committee are as follows:

A. E. Johnson, Argo Oil Corporation; **P. E. Lakin,** Shell Oil; **N. C. McGowen,** United Gas Pipe Line; **R. L. Minckler,** General Petroleum; **E. L. Shea,** The Ethyl Corporation; **A. A. Stambaugh,** Standard Oil (Ohio); **Henderson Supplee, Jr.,** Atlantic Refining; **W. K. Warren,** Warren Petroleum, and **Burl S. Watson,** Cities Service Company.

James C. Reid, vice president and operating manager of Southern Union Gas Company has been named to the newly created position of executive vice president. **H. N. Oldham,** assistant operating manager, has been appointed vice president and operating manager of Southern Union Gas.

Reid, who joined the company more than 16 years ago, first served as assistant operating manager of Southern Union's West Texas and New Mexico properties, with headquarters in Santa Fe. He has served as director, vice president and operating manager, since 1943. He attended Southern Methodist University one year before entering Yale University.

Oldham is a graduate of the University of Arkansas. A native of Oklahoma, he worked for the Oklahoma State Highway Department before he joined Southern Union more than 17 years ago. He went to Dallas in April 1950 when he was appointed assistant operating manager.

Thomas M. Moore has been promoted to group leader at the Whiting, Indiana, research laboratories of Standard Oil Company (Indiana).

Moore joined Standard in 1946 as a chemical engineer. A native of Evansville, Indiana, he was graduated from Illinois Institute of Technology.

Frank A. Morgan, vice president of Richfield Oil Corporation, was named a director of the Halliburton Oil Well Cementing Company of Duncan, Oklahoma, at a regular meeting of the board of directors in Dallas, Texas, recently. Operations of the firm are world wide in scope.

C. P. Watson, vice president in charge of the Western Division of Seaboard Oil Company of Delaware, will retire on April 30. Associated with the company since 1930, Watson has for some time desired to be relieved of his administrative responsibilities in order to be able to devote a substantial part of his time to consultation on petroleum matters, according to John M. Lovejoy, president of the company. He will be retained as a consultant by Seaboard.

Norman A. Rousselot, assistant vice president of the company, who has been Watson's assistant for a number of years, will succeed him in charge of Seaboard's Western Division.

In this case it's refining, but whether the job be refining, pumping or transmission, you'll find Electric Power on the job — rendering safe, dependable, economical service. The top photo shows the new "cat" tower of a major oil company at Drumright, Okla. The bottom photo is a view of the refinery's storage facilities as seen from atop the tower. Here, as in countless other locales, Electric Power is doing the job Let *PEP go to work for you. Consult the Power Engineer of your nearest Electric Power Company for details on how you, too, can enjoy the many advantages of Electric Power.

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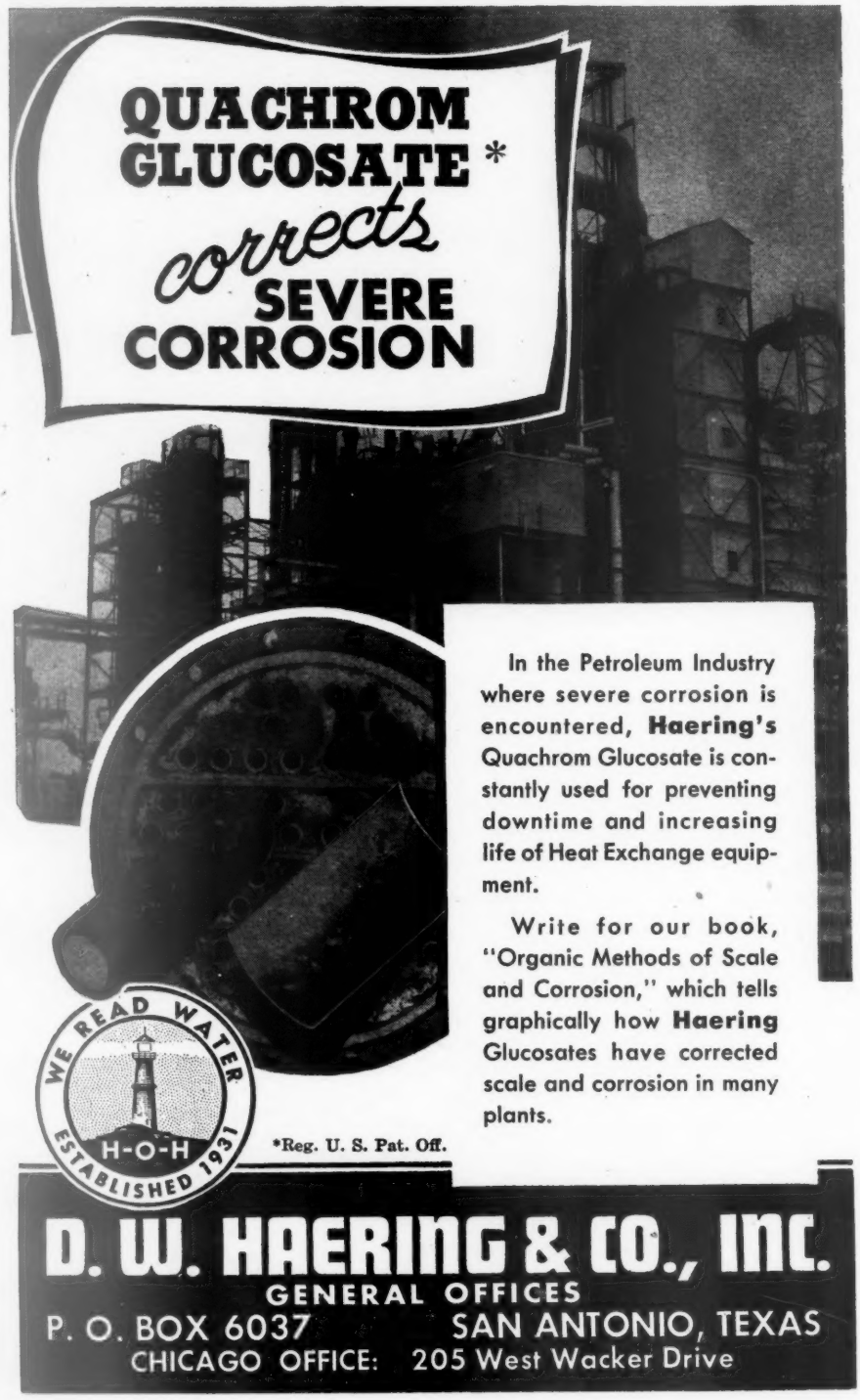
▸ **William C. Whaley,** Los Angeles, California, a vice president and director of Sunray Oil Corporation, has been transferred to the company's general offices in Tulsa, Oklahoma, where he will become a member of Sunray's executive committee and chairman of the company's operating committee. **R. E. Foss,** Los Angeles, vice president for Sunray's West Coast division, of which Whaley was formerly manager, has been named vice president and manager of the company's operations there.

In announcing Whaley's transfer to Sunray's executive department in Tulsa, C. H. Wright, president, disclosed that he is giving up the chairmanship of the company's operating committee, now to be headed by Whaley, and that **Paul E. Taliaferro,** Sunray director and vice president, will be vice chairman of the group.

Whaley began his oil experience in 1910, having field, engineering and executive experience with various oil companies. He became associated with the former Barnsdall Oil Company in 1924, became a vice president of that organization in 1931, and was made general manager of that company's California operations in 1941. He joined Sunray in June 1950 as a director and vice president when Barnsdall was merged into Sunray Oil Corporation. Foss, who will be manager of Sunray's West Coast operation, is a graduate of the California Institute of Technology, joined the former Barnsdall organization in 1935.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▸ **Chas. A. Perlitz, Jr.,** Houston, vice president and director of Continental Oil Company, has relinquished his duties as general manager of the company's southern region to become a member of Continental's executive headquarters staff in Houston. In his new position he will be in charge of Continental's transportation, crude oil trading, purchasing, and public relations activities. In addition, he will serve as chairman of the company's advisory committee, and act as liaison with subsidiary and affiliated pipe line companies.

Perlitz joined Continental as general attorney in 1946.

Continental's southern region has been divided into two regions due to the growth and expansion of company operations. Headquarters of the revised southern region will continue to be maintained in Houston, and headquarters of the newly created Southwestern region will be established in Fort Worth.

O. L. Fisher, Houston, assistant general manager of the present southern region, has been promoted to general manager of the revised southern region. **K. W. Brill,** Denver, manager of the exploration in Continental's Rocky Mountain region, has been promoted and will move to Houston as assistant manager of the southern region.

Heading the new southwestern region, with headquarters at Fort Worth, will be **H. H. Hinson** as regional general manager, and **George W. Evans,** as assistant regional general manager. Prior to their promotions Hinson was assistant manager of Continental's production department, Houston, and Evans was manager of transportation and purchasing, Houston.

▸ **James E. Seebold** has been promoted to assistant manager of research of Standard Oil Company (Indiana) with headquarters in the general office at Chicago, Illinois. **Robert A. Steel** has been promoted to succeed him as director of the process division at the company's Whiting, Indiana, research laboratories.

Dr. Seebold joined Standard in 1940 as a chemical engineer at Whiting. He was subsequently group leader, section leader, and assistant director of research before becoming director of the process division in 1950. He received his bachelor's degree from Massachusetts Institute of Technology.

Steel joined Standard in 1938 as a chemical engineer. After serving also as group leader, he was appointed section leader in 1946. He was graduated from Harvard and received his master's degree from MIT.

▸ **Ira H. Cram** has been elected a director of Continental Oil Company. Vice president in charge of exploration for Continental, Cram joined the company in January 1949. He succeeds **W. H. Ferguson,** retired executive vice president of Continental, who resigned as a director but who will continue to serve the company in an advisory capacity.

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DEATHS

Harry L. Mathers, pioneer Oklahoma oil man and drilling contractor died February 13. He was division superintendent of the Tidal and Tidal Osage oil concerns, and later joined B. L. Agnew, Royalty, Texas, as drilling contractor, operating in West Texas.

Evan D. Jennings, retired, died February 17. He was past president of E. H. Jennings Brothers Oil Company, liquidated last year.

George W. Faulkner died in Dallas February 24. He had been an employee of Magnolia Petroleum Company for 30 years.

Clarence M. Strong, director of purchases for Gar Wood Industries, Inc., died unexpectedly in Detroit, Michigan, February 23. Strong came to Gar Wood Industries in 1949 to direct the activities of all corporation purchasing departments. For many years he was active in Detroit Purchasing Agents Association.

Daniel T. Pierce, assistant to the president of Sinclair Oil Corporation for 21 years, died February 16 in New York City. He was the adviser and traveling companion of H. F. Sinclair until Sinclair's retirement from active service about two years ago. Since then he served as executive assistant to P. C. Spencer, present head of Sinclair.

Maurice E. Mennecier, veteran of 24 years with Schlumberger Well Surveying Corporation, died February 12 in a Houston hospital after a short illness. Mennecier was employed by the Schlumberger organization in 1928. He worked in France and Europe until 1938 when he came to the United States to assist in the introduction of gun perforating and give special training in the use of the new equipment.

He was then transferred to Venezuela and later to Trinidad for the same purpose. He returned to Houston in 1942 as assistant to the chief engineer in charge of gun perforating in the United States.

Ward Blackburn, who had been president of Vernon Tool Company, Ltd., Alhambra, California, for the past 15 years, died of a heart attack recently. Blackburn was a graduate of the Colorado School of Mines. He was active in the California Natural Gas Association and the Western Oil and Gas Association and other groups. Before his death he had been with Ingersoll-Rand for 25 years.

Harry T. Vogel, division manager of Signal Oil and Gas Company, died March 1, after a heart attack at his home in Fort Worth, Texas. He had spent eight years as manager of Signal's Mid-Continent division.

Morris W. Kellogg

Morris W. Kellogg, founder and chairman of the board of The M. W. Kellogg Company, died at his home in New York City, February 22. A graduate of Stevens Institute of Technology in 1894, Kellogg started the company in 1901 as a small pipe fabricating shop in Jersey City. This led to pioneering in the fabrication of penstocks for the hydro-electric power industry. The firm next turned to the manufacture of tanks for storing materials under high pressure and temperature. In late 1944 Kellogg arranged the sale of the company to Pullman, Inc., becoming a director of the parent corporation. He continued active as president of Kellogg until March of 1946, at which time he became chairman of the board.

Norman L. Dorn, vice president of Lane-Wells Company, died at his home in Long Beach, California, March 2. He has been connected with the petroleum industry for more than 30 years. Before joining Lane-Wells in 1937, he was with Shell Oil Company for 18 years in a progression of positions leading to his capacity of superintendent of production in the southern division at Long Beach.

In addition to serving Lane-Wells as vice president, Dorn directed the company's engineering activities from 1937 until February of this year, when he relinquished his title of chief engineer to become vice president and consultant. He was a graduate of the University of Nevada. Dorn served overseas with the 38th Engineers in World War I.

Adolph Leonard Weil, former president of General Petroleum Corporation, died February 25 at his home in Los Angeles. Weil became connected with the oil industry almost immediately after receiving his law degree from the University of California in 1899. His practice included problems relating to land, legislation, and taxation for several oil industry clients.

In 1910 he handled the incorporation of the Esperanza Consolidated Oil Company, which later became General Petroleum. He served as general counsel for both organizations until he retired in 1940. From 1934 to 1940 he also served as president of General Petroleum.

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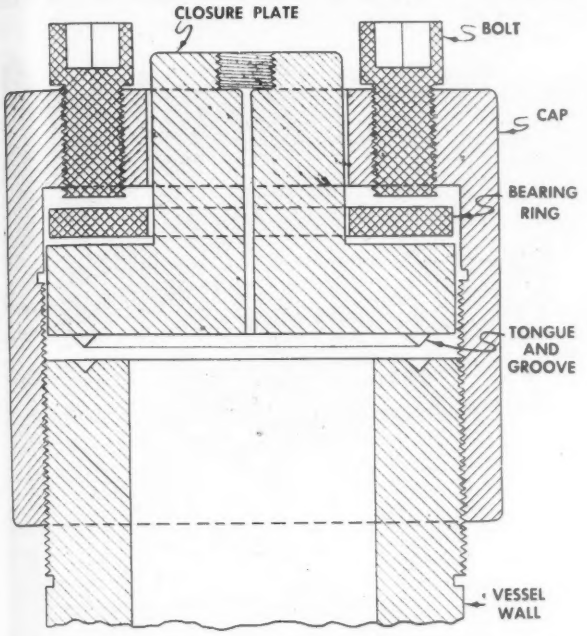
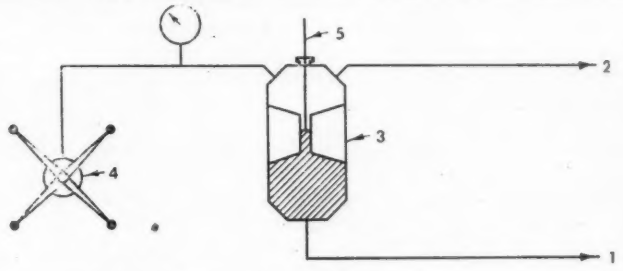


FIG. 4. Partially exploded view of cell closure.



1. Mercury line to bottom of equilibrium cell.
2. Oil line to space between windows.
3. Interface cell.
4. Volumetric pump.
5. Electrical contact.

FIG. 5. Window seal pressure system.

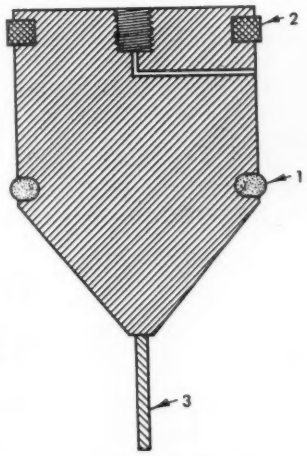


FIG. 6. Floating piston.

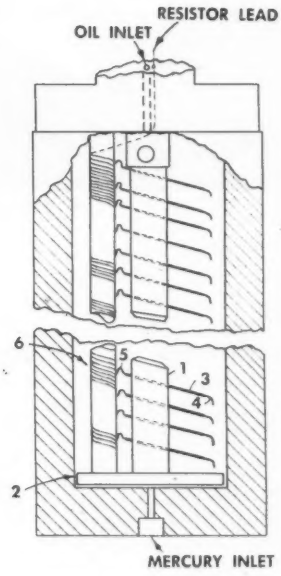


FIG. 7. Mercury volume measuring device.

Temperature Measurement. All temperatures are measured with single-junction iron-constantan thermocouples in conjunction with a Leeds and Northrup portable precision potentiometer. The thermocouples were calibrated with Bureau of Standards certified mercury-in-glass thermometers and it is considered that the temperatures in the range of 0 to 325 F are measured with an error not exceeding 0.5 F. The thermocouples are imbedded in small holes drilled ¾ in. deep in the body of the cell.

Pressure Vessels. Type AISI 410 stainless steel (12 per cent Cr) was chosen as the material for both windowed equilibrium cells and for the three MVM cells because of its resistance to corrosion by hydrogen sulfide and carbon dioxide and because it possesses a greater yield strength than most other suitable stainless steels. The design of the vessels is such that the maximum fibre stress is 20,000 psi at an internal cell pressure of 10,000 psi. The design permits use of the cells at temperatures from 0 F to 400 F with cell pressures up to 10,000 psi, and from 0 to —60 F with cell pressures up to 5000 psi. Sage[7] reported no significant amalgamation of his stainless steel (18 per cent Cr 8 per cent Ni) with mercury at 600 F. Thus it is believed no significant amalgamation will occur with the stainless steel used here.

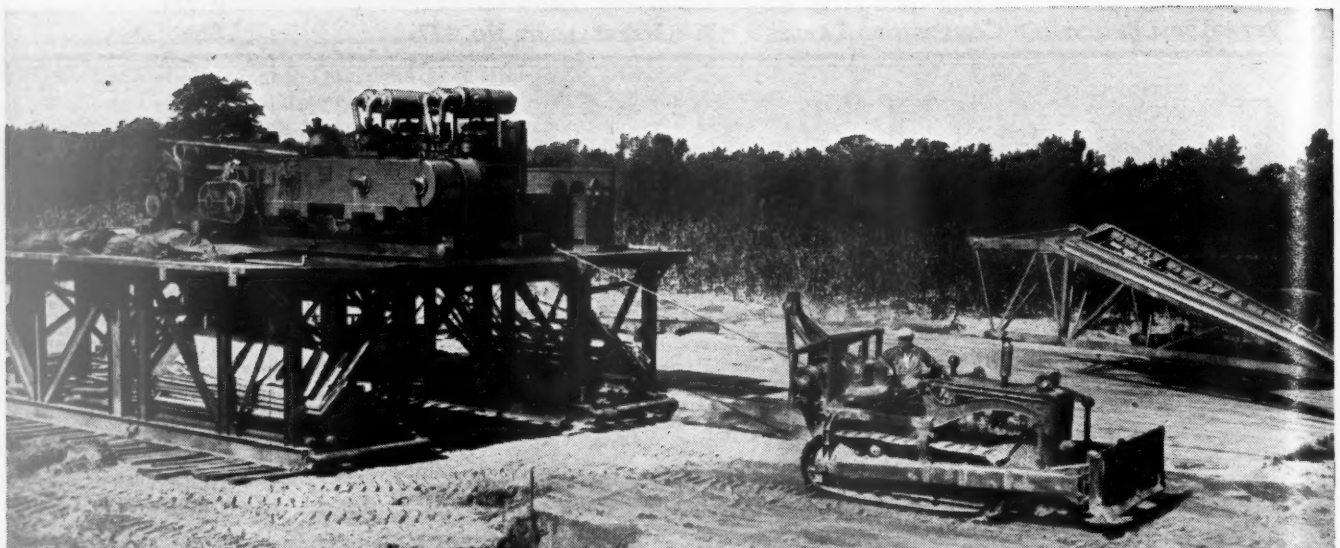
Fig. 4 shows the essential details of the cell closure. Its main feature is the absence of a gasket. The pressure seal is effected at the tongue-and-groove by pressing the ground-in surfaces together with bolts. The closures on the three MVM cells were successfully tested with oil at 15,500 psi. A torque of 70 ft-lb was applied to each bolt in making up the closure.

The design of the cell windows is essentially that as described by Eilerts[3]. It consists of a double window with a water-white mineral oil seal between the windows. The pressure on the oil between the windows is maintained equal to the pressure in the cell by an arrangement as shown in Fig. 5. The pressure from the equilibrium cell is transferred to the oil by means of interface cell 3. In order to avoid errors in volume measurement, the mercury level in the interface cell is kept at a fixed level within a constricted portion of cell 3 by means of electrical contact 5 and volumetric pump 4.

Floating Piston. A drawing of the floating piston is shown in Fig. 6. The separation between the mercury above the piston and the hydrocarbon fluid content of the cell is effected by means of rubber 0-ring seal 1 near the bottom of the piston. The piston is held in a centered position in the cell bore with piston-ring 2 made of Teflon. When the piston is at the bottom of the cell, pin 3 is used to position the piston at a reference mark on the cell windows.

Volume Measuring Device. Fig. 7 shows a section of the device as installed in an MVM cell. The device consists of two flat steel bars 1 fastened together with counter-sunk flat head screws and attached to the base of the cell closure. To the lower end is fixed a disk of Bakelite 2 having very nearly the same diameter as the interior of the cell. This arrangement maintains the axis of the bar coincident with the axis of the cell. At intervals of 7/16 in. steel pins 1/16 in. in diameter and inclosed in plastic electrically insulating sleeves are clamped between the bars. To the lower end of each pin a short length of platinum wire 4 was welded to serve as a contact point with the mercury. The upper end of each pin is welded to a different lead wire 5, from the wire wound resistor 6. The upper terminal wire of resistor 6 is conducted through the head of the cell by means of an electrically insulated lead and connected into a Wheatstone bridge.

As the level of the mercury changes the number of contacts submerged in the mercury changes and as each contact point leaves or enters the mercury the net resistance of the circuit will change in a stepwise manner. As each contact is connected into the resistor at a different level each has a



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DIGGING THE SLUSH PIT. Main pit is six feet deep, twenty yards long. Reserve pit is 25 yards in diameter.

unique resistance value that serves to identify it. The Wheatstone bridge measures the resistance of the circuit and thereby identifies the pin making contact with the mercury surface. As the vessel was fabricated to have a very nearly constant diameter (±.003 in.) the volume of mercury at each contact is a simple function of its height above any convenient reference level. In order to make the contactor unit into a device for measuring any volume it was necessary to provide a tilting action of proper magnitude to the cell so that for any mercury level a contact can be made by tilting the cell forward or backward. When contact is made, as evidenced by a sudden change in resistance, the angle of tilt is measured.

Each MVM cell was calibrated by measuring the volume of successive portions of mercury withdrawn and relating the cumulative volume withdrawn with the circuit resistance and angle of tilt required to cause the platinum wire to contact the mercury surface.

Considerable difficulty was encountered in finding a liquid to overlay the mercury which could be easily pumped at high pressures and at the same time allow exactly reproducible contacts to be made between the tips of the contact pins and the mercury surface. It was found that compounds such as acetone, alcohol, or glycerin seriously interfered with the mercury contacts. Common lubricating oil was unsatisfactory because in addition to interfering with the pin-to-mercury contact enough mercury emulsion was created to interfere seriously with the reproducibility of the readings. It was found that water-white mineral oil had all the properties desired in that it did not emulsify the mercury, it permitted exactly reproducible contacts between the pins and mercury, it could be used in the hydraulic system and pump with no dangers from corrosion and is a good lubricant.

The precision of the volume measurement is ±0.3 cc and the accuracy is considered to be ±0.5 cc for any volume within capacity of the cells.

In order to attain the greatest accuracy in making volume measurements corrections must be made for the effects of temperature and pressure upon (a) the volume of mercury in the system; (b) the volumes of the equilibrium cell and the companion MVM cell. The effect of temperature and pressure upon the mercury density was corrected for by use of the data of Smith[11]. The effects of pressure upon the volumes of the equilibrium cells and the MVM cells were determined by direct experiment. The effects of temperature on the volumes of the cells were computed.

TABLE 1. Comparison between experimental compressibility factors for methane and those by Sage[5] at 100 F.

Pressure psia	Compressibility factor: Experimental points	Smooth data —Sage	Difference
1,055	0.9007	0.903	−0.0023
2,030	0.8542	0.852	+0.0022
2,528	0.8463	0.847	−0.0007
3,029	0.8550	0.855	0.0000
4,017	0.9067	0.907	−0.0003
6,065	1.0761	1.074	+0.0021
6,759	1.1400	1.139	+0.0010
8,062	1.2655	1.261	+0.0045
10,060	1.4533	1.451	+0.0023
9,111	1.3647	1.361	+0.0037
7,143	1.1750	1.175	0.0000
5,186	0.9991	0.997	+0.0021
3,103	0.8588	0.858	+0.0008
1,078	0.8982	0.902	−0.0038
		Average deviation	0.0018
		Algebraic deviation	+0.0116

Before any volume measurement on an equilibrium cell can be made a "zero" volume indication on the appropriate MVM cell must be noted. This procedure is simple with the PVT cell and the gas-pumping cell and consists of filling the cells with mercury and noting the volume indication with the MVM cells at various pressures and at the reference temperature of 100 F. These various volume indications are then plotted against pressure, and the value at zero pressure taken as the reference or "zero" volume indication. In the case of the piston cell, the same observations are made with the stem of the piston set at the reference dot in the window.

In order to test the over-all performance of the PVT cell, the compressibility factor of methane was determined at 100 F over a range of pressures from 1000 to 10,000 psi. These experimentally determined compressibility factors are compared in Table 1 with the smoothed data published by Sage et al[5]. The small differences found demonstrate that the over-all accuracy of the pressure and volume measurements are easily within the requirements of the type of studies in which they will be used.

Fig. 8 is an example of the compressibility factor measurement of a gas-condensate system as determined in the PVT cell. The circles are the experimentally determined compressibility factors of the original fluid for the case where the pressure was reduced by increasing the volume with no change in composition. The crosses represent experimental values for the case where the pressure was reduced by progressively removing the equilibrium vapor phase thus effecting changes in composition of the fluid remaining in the cell. This operation is the equivalent of producing a gas-condensate type petroleum reservoir by pressure depletion.

Figs. 9 and 10 show the isotherms at 140.5 F and at 190.5 F of a mixture of the following composition,

	Mole per cent
Ethylene	68.3
n-Butane	31.7
	100.0

These isotherms were determined with the piston cell. The 140.5 F isotherm is in the normal region of PVT behaviors whereas the 190.5 F isotherm is in the region of retrograde behavior. The dew-point of the 140.5 F isotherm and the lower dew-point of the 190.5 F isotherm is typical of the type of isotherm which approaches the dew-point at a very sharp angle. The manner in which the dew-point pressures were determined using the piston cell is shown in Figs. 11 and 12. The liquid accumulation was plotted against the pressure and the curve extrapolated to the zero liquid accumulation line, the intersection with this line along with visual observations was taken as the dew-point pressure. The construction of the pis-

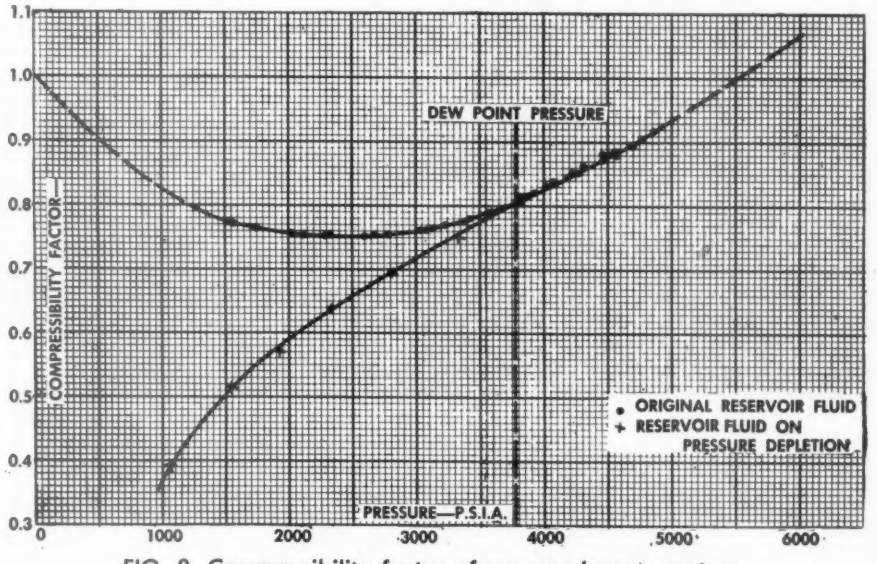

FIG. 8. Compressibility factor of gas condensate system.

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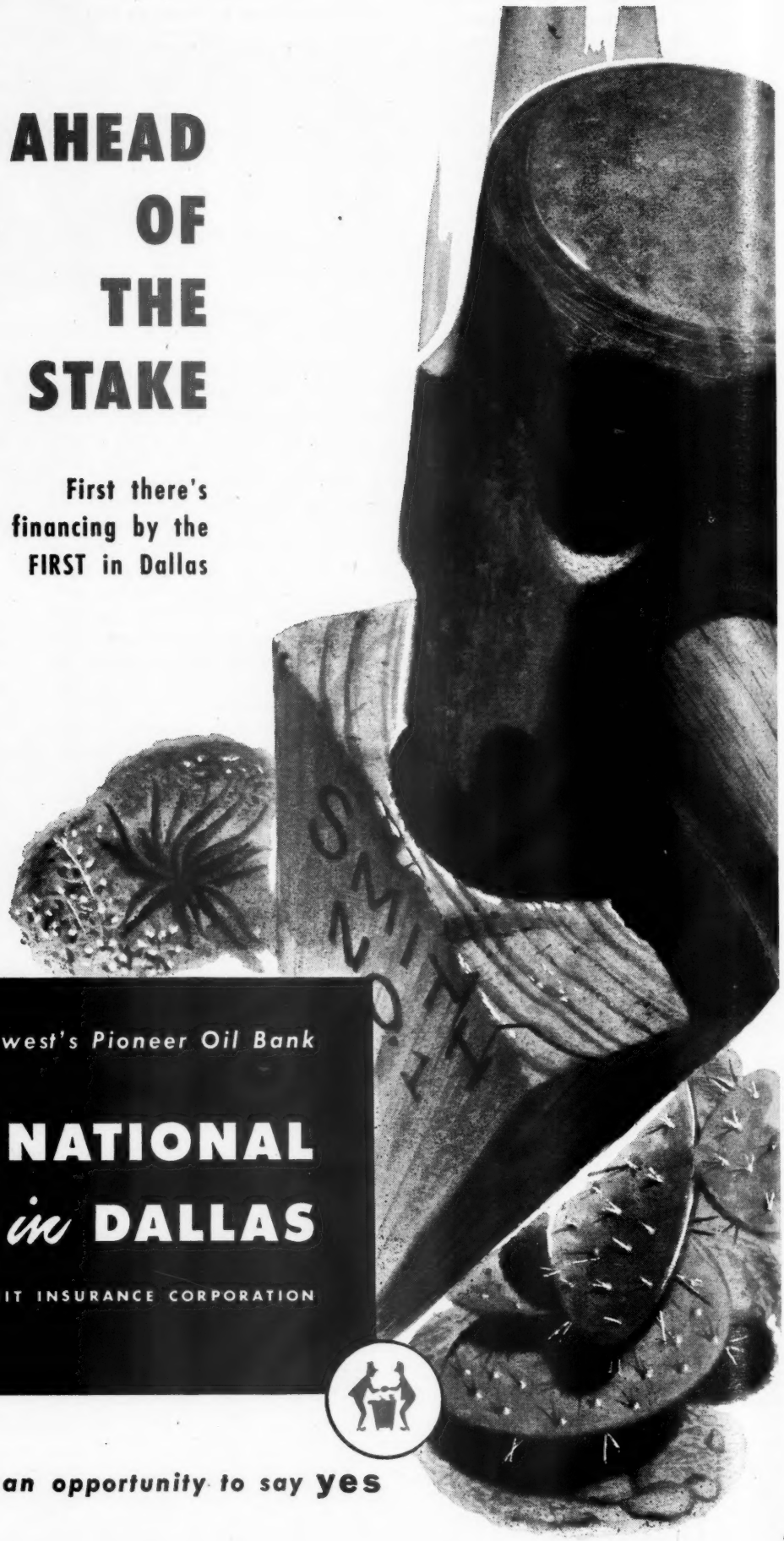

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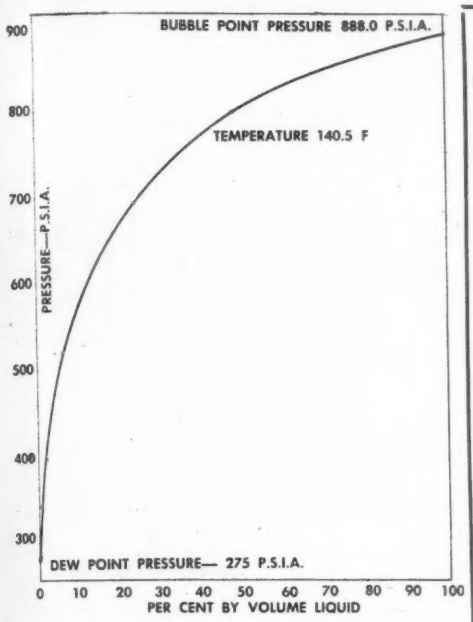

FIG. 9. Effect of pressure upon volume of liquid phase.

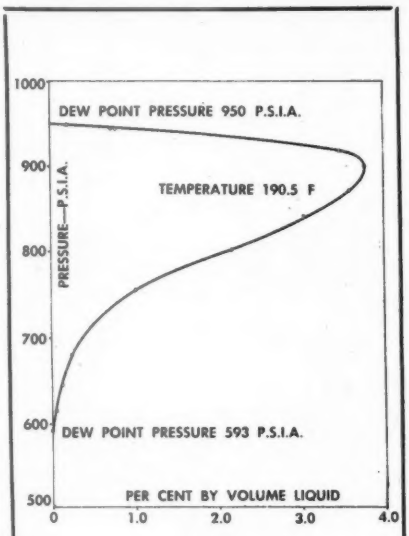

FIG. 10. Effect of pressure upon volume of liquid phase.

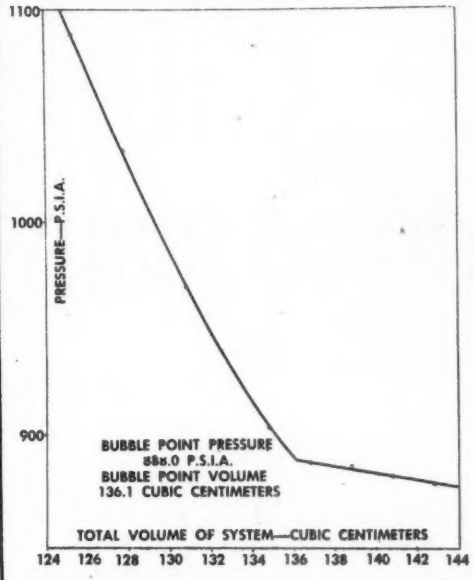

FIG. 13. Determination of bubble point pressure at 140.5 F.

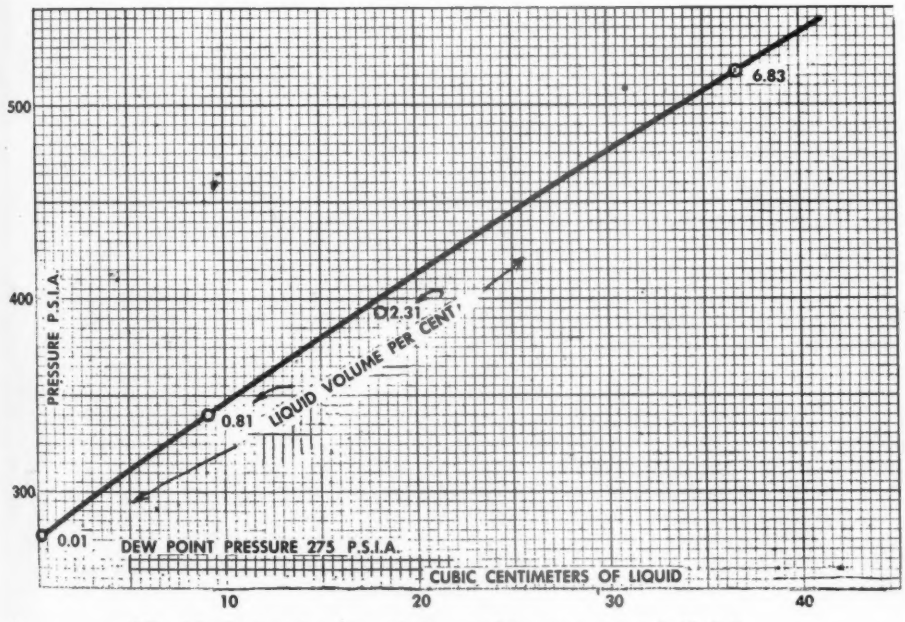

FIG. 11. Determination of dew point pressure at 140.5 F.

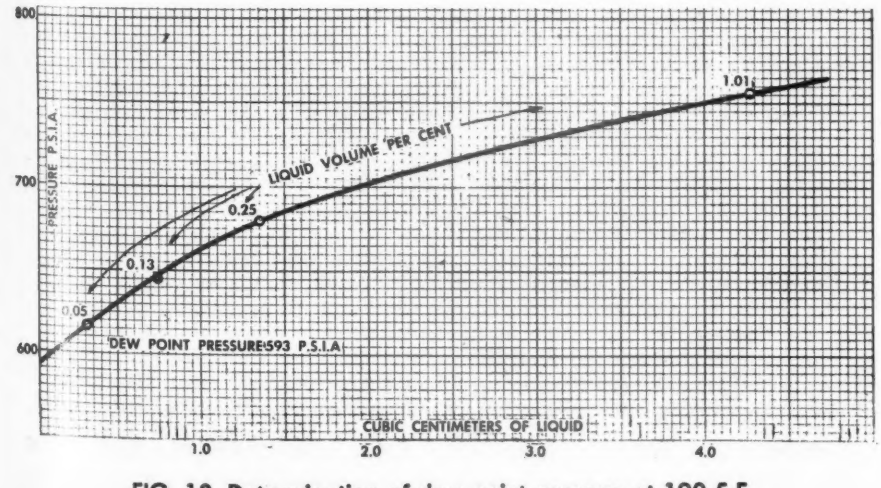

FIG. 12. Determination of dew point pressure at 190.5 F.

ton cell is such that very small quantities of liquid can be measured, this is an aid in determining dew-points of this nature. The small figures plotted alongside the experimental points of Figs. 11 and 12 indicate the percentage of the total volume occupied by the liquid phase.

The bubble-point of the mixture was determined by plotting the total volume of the system against the pressure and observing the break in the curve. The pressure at which this break occurs is the bubble-point pressure. Fig. 13 illustrates this.

The diagrams show that the various measurements necessary for a laboratory study of a gas-condensate type system can be made accurately with the equipment just described.

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Acknowledgment

The authors wish to thank Phillips Petroleum Company for permission to publish this report and A. F. Bertuzzi, R. F. Wiemer and T. A. Matthews for their aid in the assembling and testing of the equipment. * * *

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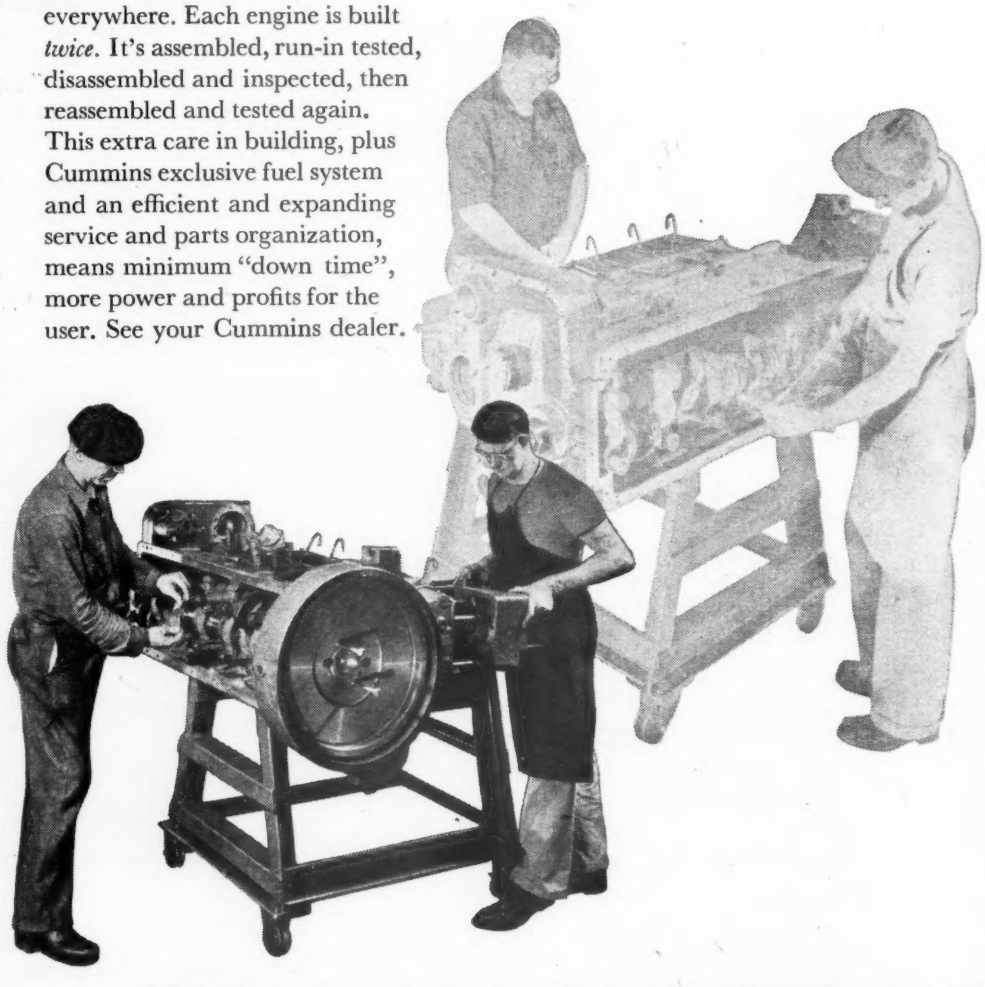

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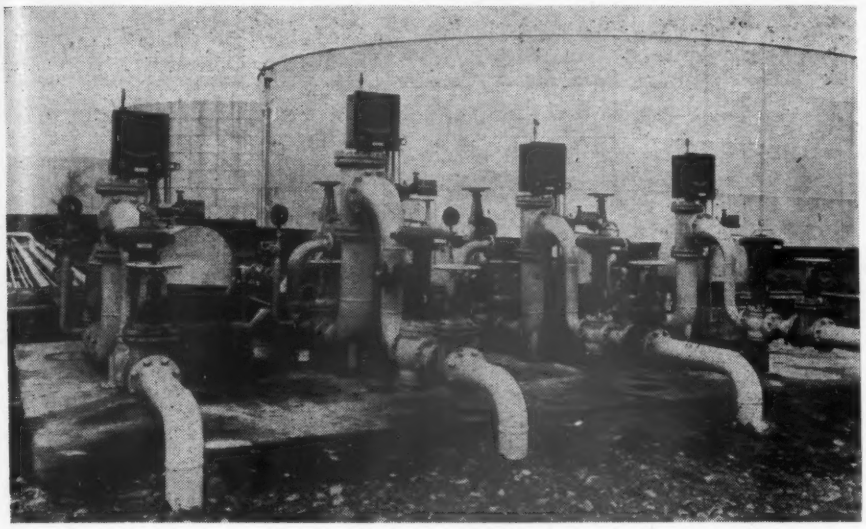

FIG. 1. Ratosleeve Magnabond transmitter-controllers measuring and controlling ingredient flow rates in the first large gasoline line blending system at Shell Oil Company, Montreal, Quebec, Canada.

The Author

John O. Larson, vice president, Fischer and Porter Company, was graduated from Illinois Institute of Technology (Armour) in 1936 with BS in civil engineering. The recession of 1938 found him stranded in the Cincinnati, Ohio, area where he decided process work would be better than construction. He worked in instrumentation at Procter and Gamble's Ivorydale plant, and went with Foxboro in 1940. Larson joined Fischer and Porter in 1944 after several months' assignment to industrial instrument branch at the War Production Board. He worked in the New York office until August, 1950, when he returned to Hatboro for his present responsibility.

Area Type Meters in Refining Applications

They can be used to advantage in corrosive fluids, where vapors are formed or where solids are found in fluid

JOHN O. LARSON*

A RECENT flow measurement handbook, essentially a reprint of the standard practice of one of the large refiners, indicates that area type meters (rotameters) are being utilized to meet 4.8 per cent of the flow rate measurement applications in a "typical large refinery." This was contrasted with 89.2 per cent usage of orifice meters.

Such a comparison shows that area meters such as the Fischer and Porter Flowrator meter are not today a basic tool of the average refinery instrument or process engineer, even though—as we will demonstrate later — a significant number of applications are being very successfully handled.

We cannot perceive any "Doppler Effect" that all might recognize as assuredly telling whether the Flowrator meter is progressing or receding as regards present popularity. It is believed, however, that there have been a sufficient number of applications, ranging from purge meters or flow rate indicators on pump gland seal oil to complete measuring and proportioning systems, to have placed the matter before refinery technical personnel, and the immediate future should show the trend. Of course, a significant fact has been the lack of experience and sophistication on the part of area meter suppliers. By and large, the Flowrator meter has been built for the special requirements of the chemical process industries with corrosion resistance, rangeability, and other advantages of the area type meter providing principal requirements. It is to be conceded that experience has had to be obtained before refinery requirements of safety, flexibility, and adequate information could be met.

This company has recently published an area meter handbook, which presents complete data for the specification, use, and modification-in-the-field of Flowrator meters that represents one of the largest strides yet taken to meet the needs of the industry. Consistent with this standardization of metering elements is the design and production of a simplified and economical Armored Flowrator meter, utilizing a precise cold formed metal metering tube and adaptable to any type of indicating or transmitting extension that can be easily applied and reapplied to various problems as the orifice meter. (see Fig. 2 external and section 2 and 3).

EXCLUSIVE

It seems necessary to fall back upon the introductory comments of that handbook to compare the variable area (Flowrator) meter and the variable head (orifice) meter such that the proper use of each device can be assured and the future significance of each device can be better estimated.

In the accompanying list, it can be seen that the area meter principle brings about certain distinct advantages. Though still an inferential device, it more closely represents a meter that can be calibrated and tested in any laboratory and brought to any point of use with assurance that subsequent data will agree with the response and the accuracy of certification tests. Of course, this statement is not made to imply, as it might have in the past, that each Flowrator meter must be calibrated previous to its installation. With the ad-

LAUGH with BARNEY

"I love to go to Washington, D. C.—if only to be near my money."—*Bob Hope.*

* * *

Judge: Are you sure this man was drinking?

Officer: Well, sir, he was carrying a manhole cover, and said he was going home to play it on his record player.

* * *

This actually took place at a little church in the southern part of Wayne County, Mississippi, last week.

At the end of one of the long sermons of the colored churches, one of the deacons got up to pray for the "pure" and the "humble."

A devout negro member in the back of the congregation rose to make this comment:

"Let's pray for Mr. Sistrunk, too. He's got my lease."

* * *

An officer approached a drunk who was trying to get the key into his car door lock.

"Look here," he said, "you don't mean to tell me that you intend to drive that car?"

"Sure," replied the soak. "Can't you see I'm in no condition to walk!"

* * *

The trouble with resisting temptation is that it may never come again.

A lawyer journeyed to a neighboring state to try an important case, promising to wire his partner the moment a decision was announced. At last the wire arrived. "Justice has triumphed!"

The partner indignantly wired back: "Appeal at once!"

* * *

Comment on a glamour gal in a television show: "What an evening gown! You couldn't tell whether she was inside, trying to get out, or outside trying to get in."

* * *

"Too bad about Joe Stalin."

"Why? What happened to him?"

"Nothing."

* * *

"Yes, I am a self-made man."

"Sir, you have relieved the Lord of a great responsibility."

* * *

"Halt; who goes there?"

"American."

"Advance and recite the second verse of 'The Star-Spangled Banner.' "

"I don't know it."

"Proceed, American!"

* * *

Teacher: Where is the capital of the United States?"

Young Sage: In loans, all over the world.

We understand that manufacturers of a certain feminine garment are currently making only three kinds: The Russian type, the Salvation Army type, and the American type.

The function of the Russian type is to uplift the masses; the Salvation Army type is to raise the fallen; and the American type is to make mountains out of molehills.

* * *

Gold-digger: A girl who mines her own business.

* * *

California and Florida vie in the production of tropical products, and Washington furnishes a goodly crop of lemons and nuts.

* * *

Groucho Marx was dining in a Hollywood restaurant when the bus boy, carrying a huge tray of glasses, stubbed his toe. The restaurant was, for a moment, stunned to silence. Then Groucho rose to the occasion.

"Ladies and gentlemen," he announced, "that was Johnny you just heard — stepping out of thousands of store windows all over the country."

* * *

Englishman No. 1: Terribly sorry you buried your wife yesterday.

Englishman No. 2: Had to—dead you know.

* * *

"Mama," said little Elsie, "I never see any pictures of angels with whiskers. Do men go to heaven?"

"Well," said mother thoughtfully, "some men go to heaven, but they get there by a close shave."

* * *

Guests at a New York dinner party were invited to come dressed to represent the title of some famous book. An elderly lady was unanimously awarded first prize when she appeared with a large picture of the Dionne quintuplets pinned across her gown. She represented Sinclair Lewis' "It Can't Happen Here."

* * *

"You know, Rastus, dat every time I kiss my wife she close her eyes and holler."

"I'll say she do!"

"What's dat?"

"I say, she do?"

* * *

The owner of a small cabaret had asked me to print a sign reading "Gentlemen" for his establishment. Thinking to dress it up a bit, I added the French "Messieurs," the Spanish "Senores," the Italian "Signori." And from an old plate I copied some Chinese characters, sure no one would have any more idea than I of their meaning.

A few weeks later the proprietor informed me that a Chinese student had been convulsed with laughter upon seeing the sign. When translated, it read: "Chinese Relief."

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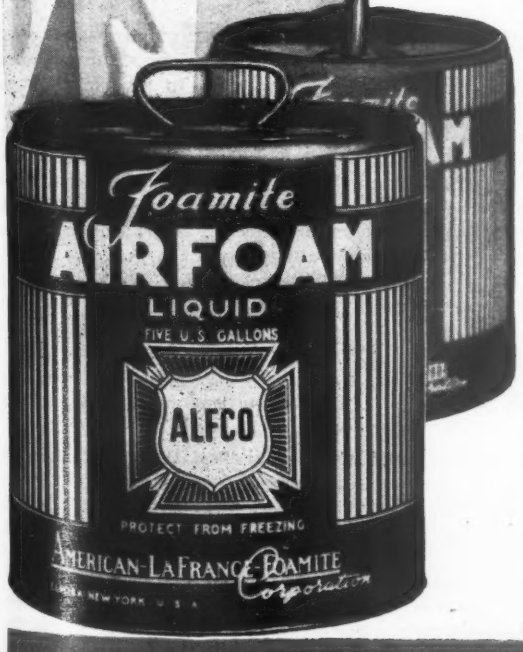

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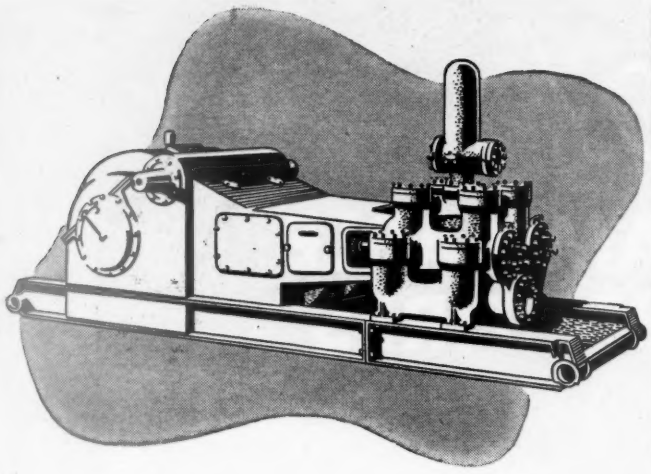

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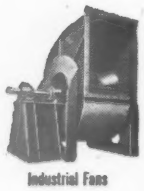

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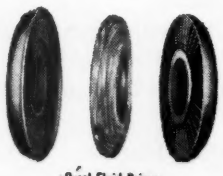

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BOOKS

The Making, Shaping, and Treating of Steel, *by J. M. Camp and C. B. Francis. Published by United States Steel Company, Pittsburgh, Pennsylvania. Pages, 1584. Price, $7.50.*

An extensive, even a prodigious, volume devoted to a compilation of past and present practices in the iron and steel industry, has been published in the Sixth Edition. The information contained in the book is the work and opinion of many authors based upon many years of practical experience. A valuable book for study and reference, "Treating of Steel" devotes many of its pages to explanatory drawings and photographs. Fundamental principles of chemistry and physics; iron ores; fuels; manufacture of pig iron; various manufacturing processes; construction of heating facilities; preparation of semi-finished steels, and many other subjects are covered.

Proceedings of the Fourteenth Technical Conference on Petroleum Production, *published by State College, Pennsylvania; Price, $3. Pages, 265.*

These Proceedings present the results obtained by the South Penn Oil Company in plugging experiments under carefully controlled conditions. From 1946 to 1950, 820 water input wells were treated with material for plugging the loose streaks. The results obtained are conclusive evidence of the value of the co-operative research program. The water input was decreased by almost 30,000,000 bbl valued at over $1 million, pumping costs were reduced and 272,000 bbl of oil, which otherwise would have been lost, were produced.

Subjects include: Selective plugging at Bradford field, increased oil recovery from long core water floods, effects of low pressure gas saturation on the physical properties of Bradford crude, effect of velocity in water flooding, and a new approach to the problem of porosity measurement.

Energy Sources—The Wealth of the World, *by Eugene Ayres and Charles A. Scarlott. Published by McGraw-Hill Book Company, 330 West 42nd Street, New York 18. Price, $5. Pages, 338.*

Here is an analysis of the question of how long the existing fuel supplies will last, and what we can do against the day when they are exhausted. There is an attempt to give a thorough census of our existing and potential fuel resources with many statistical tables. Oil, coal, hydro-electricity, solar and nuclear energy, even wind and tide power are fuel sources covered. An interesting chapter entitled, "Energy Balance Sheet" is included in the book, as well as conjectures regarding the future status of the several types of energy sources. The authors picture modern man as standing today at the highest peak in his history, each with the quivalent of 200 slaves at his beck. They point out that man's resources are dwindling due to inefficiencies, but maintain a faith in his adaptability and in his mental resources.

Modern Pyrometry, *by Charles H. Campbell. Published by Chemical Publishing Co., Inc., 26 Court Street, Brooklyn, New York. Price, $4.00. Pages, 147.*

The brief study of pyrometry is arranged to cover both the more common practices and the most recent advances in this important field. Written from the viewpoint of "What is used for these purposes, and what results are obtained," it takes up types and uses of thermocouples, tubes, and leads, their insulation, thermoelectric effects observed and other phases. One chapter covers temperature indicators, records, automatic units. Resistance, optical, radiation and other pyrometer types are covered in a third chapter while the fourth is devoted to the application and maintenance of these types of instruments. The work is designed primarily for the relatively untrained student of pyrometry, is written in simple language, and should appeal to the refinery or other chemical plant employe who has little if any formal education in the field but who wishes to know something of the elements and practical fundamentals of these instruments and their use.

Introduction to Geophysical Prospecting, *by Milton B. Dorbin. Published by McGraw-Hill Book Company, 330 West 42nd Street, New York 36. Price, $7. Pages, 416.*

Fundamental methods and principles of geophysical prospecting are presented in this volume. The following aspects are covered: Fundamental physical principles, instrumentation, field techniques, reduction of field data, and interpretation of data. Limitations of each method are covered, and examples presented of results obtained from each technique. Recent advances, such as: Aeromagnetic prospecting, underwater gravity and seismic exploration techniques, prospecting for radio-active minerals, and the Poulter method of air shooting for seismic reflection, are also examined.

Reviews of Petroleum Technology, *Vol. II (1949) Published by The Institute of Petroleum, 26 Portland Place, London, W.1. Price, 27 s. 6 d. Pages, 274.*

Volume II of the Institute's "Reviews of Petroleum Technology" contains a record of the progress made in science and technology of petroleum during 1949. As in previous years, the volume contains many references, this time to nearly 3000 technical papers and articles. The present volume also reviews plant instrumentation for 1947-9, crude oils for the same period, and insulating and hydraulic and bitumen for the years 1948-49.

Symposium on Methods of Measuring Viscosity at High Rates of Shear, (STP. No. 11) *presented to the API Committee on Petroleum Products, 1949. Published by American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pennsylvania. Pages, 47. Price, $1.35.*

The purpose of this symposium was to find a suitable method for testing viscosity at high rates of shear of various additives used in lubricants and fluids. Interests in the subject stems from the increased use of additives of various types in lubricants and fluids, and the fact that the resulting viscosities of such products may vary with use, in which case, the value obtained in conventional equipment might not indicate their performance in use. Existing methods proved unsatisfactory due to unknown temperature values; therefore, two promising methods were investigated. The results are described in detail.

Life and Death of An Oil Man. *The career of E. W. Marland, by John Joseph Mathews. Published by The University of Oklahoma Press, Norman. Price, $3.75. Pages, 259.*

E. W. Marland, one of the great figures in the history of American oil, came out to Oklahoma from Pittsburgh shortly after the beginning of the nineteenth century. He had found oil in Pennsylvania and West Virginia, and he struck oil many times in Oklahoma, Texas, New Mexico, and Central America. Having become one of the nation's biggest plungers in oil, he one day lost his luck and plunged to financial disaster. The story of how he came to his downfall is a study in high finances. A personal impression rather than a documented biography, the story of Marland, in the eyes of the author, represents all the tensions and the paradoxes of the "Age of Freedom."

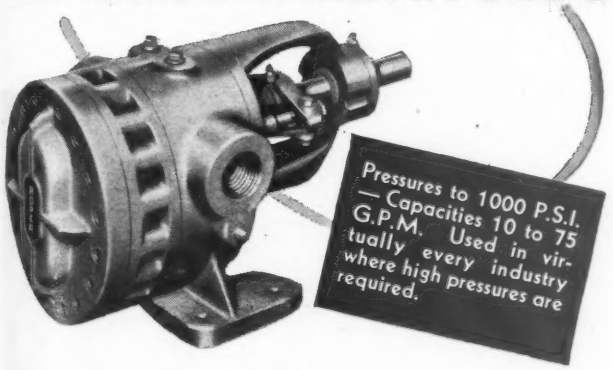
Clear Writing for Easy Reading, *by Norman G. Shidle. Published by McGraw-Hill Book Company, 330 West 42nd Street, New York 36. Price, $3. Pages, 171.*

This book describes and teaches the application of a specific method for writing reports, letters, memoranda, articles, or any kind of writing which attempts to explain, sell, or influence its readers. Numerous examples are given, drawn from business, professional, and social experience. The everyday tasks of writing office memoranda, reports, minutes of meetings, and letters of all types are given special attention.

The Engineers' Illustrated Thesaurus, *by Herbert Herkeimer. Published by The Chemical Publishing Company, 26 Court Street, Brooklyn 2, N. Y. Price, $6. Pages, 557.*

A one-volume encyclopedia of machine designs, this book contains over 8000 illustrations of mechanical movements, machine parts and details. Anyone who devises, improves, simplifies, designs, or selects such elements will probably find this a comprehensive reference book. Classified and arranged for quick and easy reference, the book also contains illustrations and sketches of every type of machine element mentioned.

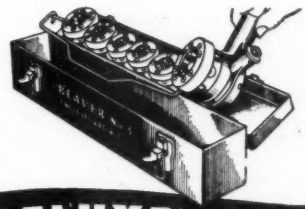
WHEN THE HIGH PRESSURE IS ON...
RELY ON ROPER SERIES H PUMPS



Pumps built especially to develop pressures up to 1000 p.s.i. High volumetric efficiency provided by equal size spur gears operating in axial hydraulic balance . . . roller bearings and bronze wear plates reduce friction under heavy load conditions . . . splined drive shaft absorbs thrust loads. Most models can be direct connected, chain, belt, or gear driven. Specify Roper for *your* high pressure job.

Geo. D. Roper Corp.
724 Blackhawk Park Ave.
ROCKFORD, ILLINOIS

ROPER Rotary Pumps



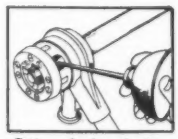
A DELUXE TOOL
with enclosed ratchet — for safety

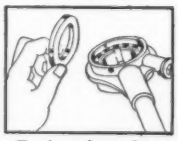
BEAVER NO. 3

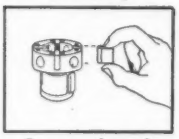
THREADS PIPE 1/8 TO 1 INCH
THREADS BOLTS 1/4 TO 1 INCH

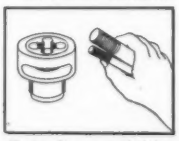
● A world-wide favorite for 40 years. Ratchet teeth fully enclosed —for safety. Openings between dies for easy oiling and chip clearance. Dies square in shape—no weak sections. Can be inverted for close threading. Made right or left-hand. Dies available for conduit and brass tubing. Die head carrier, free. Metal case available, extra. Write for new catalog.

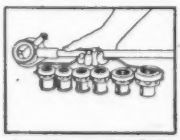
BEAVER PIPE TOOLS
256-300 Dana Ave., Warren, Ohio, U.S.A.
"Over 50 Years of Friendly Service"


Oil and chip holes between dies.


Enclosed ratchet for safety.


Square shaped dies, no weak section.


Bolt dies available.


Handy carrier furnished free.

To obtain more information on products advertised see page E-51

OIL AND GAS TRADE NEWS

Chiksan Establishes New Sales Development Office

A new sales development department has been set up in the Chiksan Company. E. Nelmes Thomas, formerly assistant manager of the sales promotion division of Commercial Solvents Corporation, has been appointed manager of the new department and will make his headquarters at the company's main plant in Brea, California.

E. N. Thomas

The sales development department was established to integrate the expanding sales promotion activities of Chiksan Company. Among the department's major functions will be the handling of the advertising and sales promotion programs, sales analysis and market research.

New BS&B Facilities Built At Odessa, Texas

Henry A. Ruysser, Jr., vice president and general sales manager of Black Sivalls and Bryson, Inc., announces the construction of a new welding shop at Odessa, Texas. The new building will have a floor space of 7800 sq ft and will be served by overhead cranes that will also extend over an adjoining slabbed area of 2500 sq ft. A railroad spur connected to the shop will enable all materials and equipment to be unloaded by shop cranes. In addition to the welding shop, a new wood shop for the re-shopping and repairing of wood tanks, and including facilities to fabricate new tanks is being built. A third unit, which is already completed, is a 7500 sq ft steel building, which serves as an office-warehouse.

Lufkin Notes 50th Year At Annual Sales Meet

Lufkin Foundry and Machine Company's annual sales conference coincided with the fiftieth anniversary of the company. In picture below are:

Front row: R. C. Thompson, Dan W. Martin, M. L. Wilkinson, L. A. Little, W. W. Trout, A. E. Cudlipp, C. M. Wooten. Second row: D. A. Reid, Jack Gissler, Ben C. Sargent, Jr., E. H. Bounds, Robert Lang, Bayo Hopper, A. V. Simonson, Vernon Glenn, Louis Fincher. Third row: Newell Lynch, Robert Poland, Charles Dyer, W. T. Crowder, Jr., B. C. Burnette, E. P. Trout, V. J. Fawcett, Byron Robbins, J. E. McGranahan, Homer Thrash. Fourth row: Bob Spaulding, A. E. Caraway, Ernest Slaughter, Jr., G. W. Nichols, T. A. Banta, John W. Swanson, Jr., W. H. Miner, Elvin Read, Harold D. Bowerman, L. Carl Frazier, Hubert Dyer, Cooper Richards, T. L. Bowers, Val Gallia, G. L. Vickrey. Top row: W. A. Kirkland, H. H. Muller, Oliver McKay, Ed Terrill, Jr., Lewis W. Breeden, J. Taylor Hood, Jack Read, R. S. Miller, John D. Mettauer, Fred Griffin.

Barchard Heads New America Meter Division

J. W. Ostler, manager of Canadian Meter Company, Ltd., Hamilton, Ontario, "Maple Leaf Division" of American Meter Company, has announced that Barchard Engineering and Equipment of Edmonton, Alberta, will now be operating as the Western Division of Canadian Meter Company, Ltd., at the same headquarters, 10970 — 124th Street. Simultaneously, Ostler announced appointment of F. M. Barchard as manager of the new division, which will operate in British Columbia, Alberta, Saskatchewan, and Manitoba.

F. M. Barchard

West Texas Agents Named

Detroit Diesel Engine Division of General Motors announces the appointment of Diesel Power, Inc., of Plainview, Texas, as distributors for GM diesel engines in the Texas Panhandle. According to the announcement, the new company will handle sales and service in the petroleum and industrial fields from their headquarters in Plainview and through dealer outlets in Perryton and Friona, Texas. The company is headed by Fred L. Manton, assisted by L. H. Donnell, manager; J. W. Hamby, sales, and Leon Cloyd, parts manager.

Lufkin Foundry and Machine Company men at annual sales meeting.

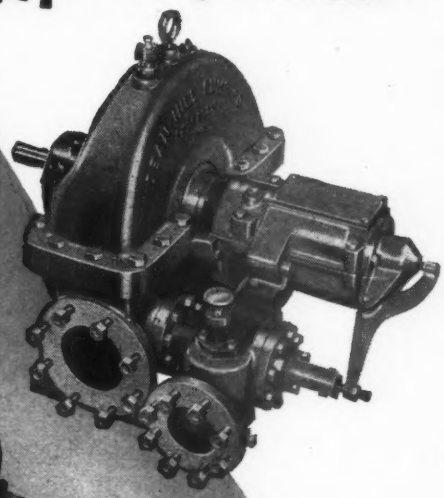
MORE POWER TO YOU

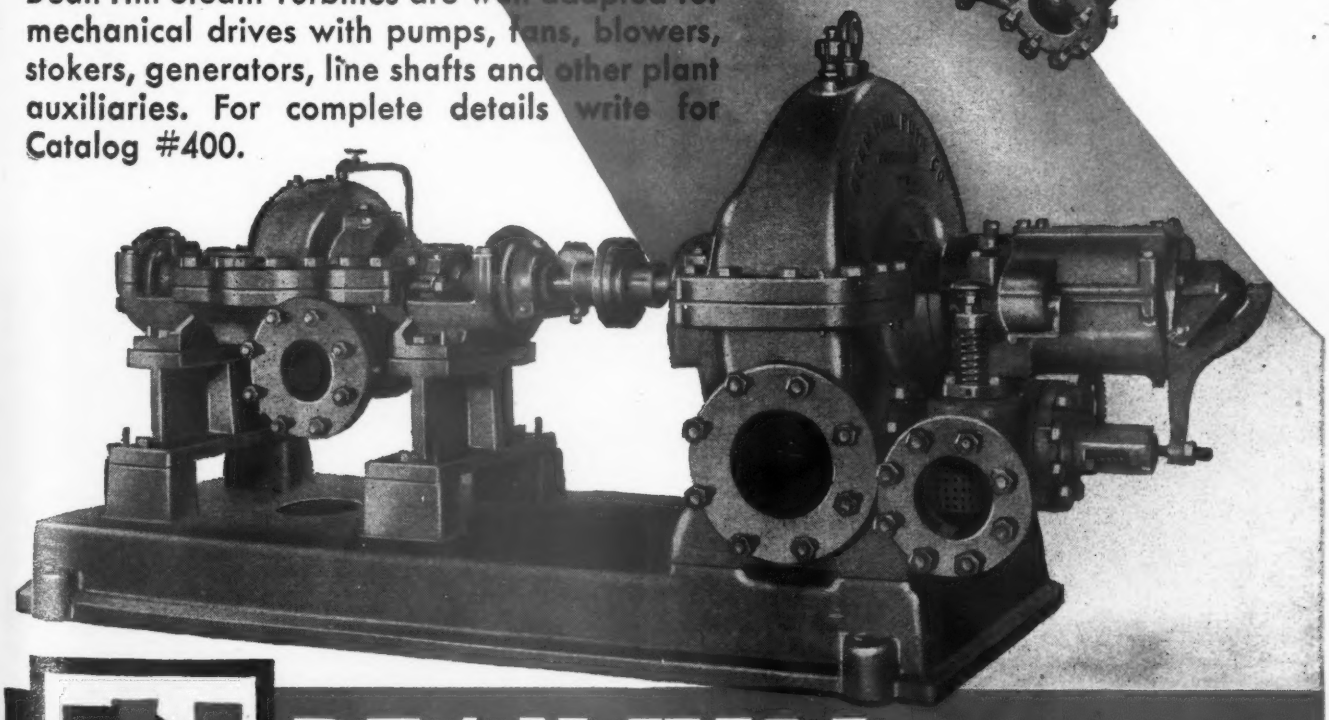
with DEAN HILL STEAM TURBINES

DH Steam Turbines are double impact type. Steam is directed twice against a single row of blades by use of special steam-reversing nozzles, thus giving double impact to the rotor and converting energy within the steam into useful power.

HORSE POWER UP TO 1000 — PRESSURES UP TO 875 lbs. — 750° F.

Dean Hill Steam Turbines are well adapted for mechanical drives with pumps, fans, blowers, stokers, generators, line shafts and other plant auxiliaries. For complete details write for Catalog #400.





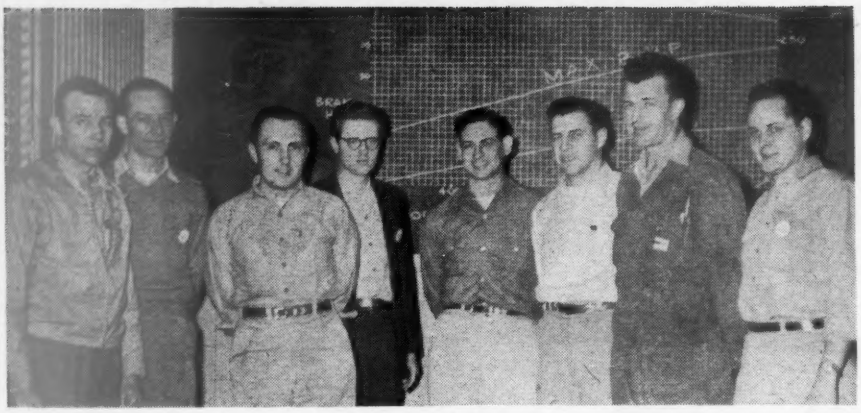
DEAN HILL PUMP COMPANY

INDIANAPOLIS 7, INDIANA

SALES OFFICES IN:

CHICAGO, MEXICO CITY, PHILADELPHIA, SALT LAKE CITY, NEW YORK, DALLAS, NEW ORLEANS, SAN FRANCISCO, DENVER, LOS ANGELES, PITTSBURGH, HOUSTON, ST. PAUL, CLEVELAND

PUMP ENGINEERS SINCE 1895



National Supply trainees and supervisors study engines.

D+B Division Holds Annual Sales Meeting

D+B Division of Emsco Derrick and Equipment Company held its annual sales conference in Dallas, Texas, recently. The combined sessions were attended by district managers and salesmen for the California and Mid-Continent divisions.

Seen in picture below are: Back row, J. S. Page, L. G. Evans, JoEarl Morris, W. C. Kinder, J. G. Hast, G. H. Lewis, L. M. Bush. Fourth row, J. A. Long, W. O. Wells, J. A. Francis, R. T. Enloe, W. L. Clowdus, J. W. Mackey, M. H. Miller, J. E. Oster, J. L. Stanford. Third row, M. E. Moore, W. L. Waddle, R. L. Brower, T. A. Mann, H. L. Jones, W. N. Wells, J. F. Cook, M. A. Lee, A. H. Johnson, E. R. Persons, R. W. Wildman. Second row, V. L. Lewis, G. W. Mills, J. F. Belk, F. C. Phillips, G. L. Hensley, C. W. Ligon, A. M. Heckler, L. E. Fullingin, D. E. Welker. Front row, L. L. Thornton, J. M. Guinn, J. D. Poole, D. F. Barton, J. L. Thompson, H. C. Gray, F. D. Turner, T. C. Berryhill, W. R. Johnson.

Lightbourn Is Distributor

W. S. Lightbourn

Lightbourn Equipment Company, Dallas, Texas, has been appointed a distributor for Rockford Clutch Division, Borg Warner Corporation, Rockford, Illinois. The company will serve oil field and industrial trade in Texas and part of Oklahoma on Rockford industrial power take-off assembles, gear reduction units, clutches and repair parts.

Baker Opens Williston Office

Baker Oil Tools, Inc., has announced the opening of its new branch office and warehouse at Williston, North Dakota, to serve the promising Williston Basin area. Ben Spingath, formerly of Baker's Casper, Wyoming, district office, will be the Williston Branch representative. Branch warehouseman at the Williston office will be Gordon M. Anderson.

Trainees Study Sales Work

To familiarize six of its engineering and sales trainees with the construction and production of oil, gas, and steam engines, National Supply Company recently sent them to a two-day program of study at Ajax Iron Works in Corry, Pennsylvania.

Trainees who took part in the program are: G. W. Hurtt, Howard Tait, supervisor of personnel training; and trainees Fred Westphal, Kenneth Palmer, Murdoch Young, Bill Robinson, Clayton Shultz, and Dale Bannon.

Cleco Names Distributors

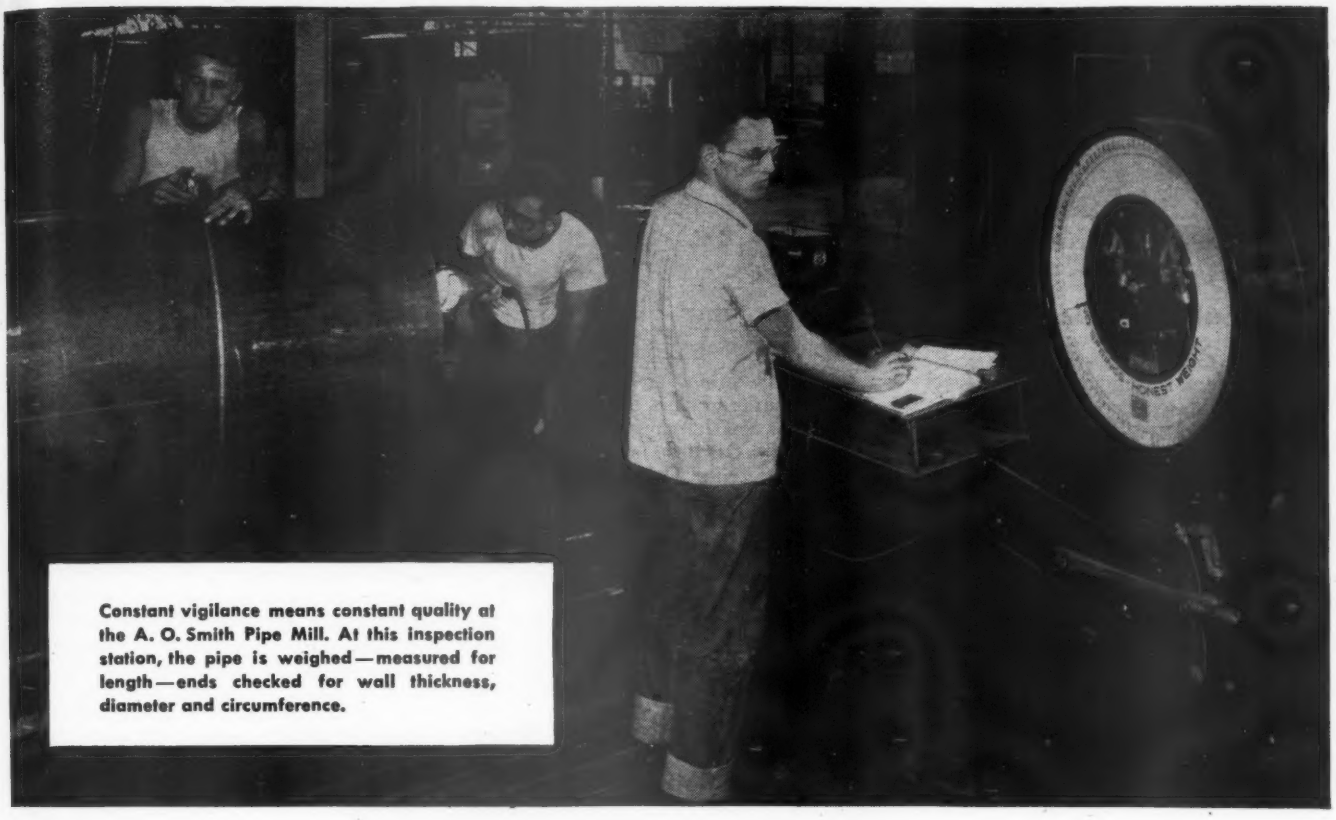
The Cleco division of the Reed Roller Bit Company, has announced the appointment of Arrow Supply Company, Inc., 3616 Liberty Avenue, Pittsburgh 1, Pennsylvania; Peerless Supply Company, 1118 Grand Avenue, Des Moines 9, Iowa; and Bates Supply Company, 11 Vernon Street, Quincy 69, Massachusetts, as distributors for Cleco products.

McCullough Tool Opens Two Canadian Offices

The McCullough Tool Company announces the opening of two new Canadian service branches at Calgary, Alberta and Regina, Saskatchewan. Edwin "Ted" Thurston has been appointed manager of the Calgary branch. He has worked as a drilling foreman for Commonwealth Drilling Company and Shell Oil Company. For the past two years he has been working out of the McCullough Edmonton service branch as a fishing tool service engineer. Loyal M. "Pete" Oaks, a veteran of 23 years in the fishing and drilling business, has been appointed manager of the Regina branch. Oaks has been with the McCullough Tool for over 10 years, the last two years working out of the Edmonton service branch, as service engineer.

Emsco Derrick's D+B Division salesmen holding conference in Dallas, Texas.

FIRST names in pipelines depend on the FIRST* name in line pipe



Constant vigilance means constant quality at the A. O. Smith Pipe Mill. At this inspection station, the pipe is weighed—measured for length—ends checked for wall thickness, diameter and circumference.

A. O. Smith contributes toward lower pipe line installation costs

Uniformity contributes to the quality of the pipe and thus reduces the cost of installation. Uniform, round ends of consistent wall thickness makes for faster lineup in the field—simplifies the welding procedures—reduces total installation time. These are important contributions toward reducing the overall cost of the pipe line—an economic advantage enjoyed by A. O. Smith customers.

To Begin With, plate is used that comes from the mill in uniform thickness and permits careful inspection of both surfaces.

Then our internal expanding process (in use by A. O. Smith for over 20 years) makes certain the pipe is round, straight and of uniform diameter.

Finally complete inspection both during manufacturing process and after finishing makes sure that all pipe shipped meets the high standards established by A. O. Smith.

* **FIRSTS** by A. O. Smith • Welded line pipe • Internal expanded pipe • Light wall large diameter pipe • World's largest producer of large diameter welded steel pipe.

DEPENDABILITY *through* **RESEARCH** *and* **ENGINEERING**

78th ANNIVERSARY 1876 - 1952

A.O.Smith

LINE PIPE • CASING

Chicago 4 • Dallas 2 • Denver 2 • Houston 2
Los Angeles 22 • Midland 5, Texas
New Orleans • New York 17 • Pittsburgh 19
San Francisco 4 • Seattle 1 • International Division: P.O. Box 2023, Milwaukee 1

To obtain more information on products advertised see page E-51

Larkin Packer's sales force seen at a 4-day meeting in St. Louis, Missouri.

Larkin Sales Meeting Held in St. Louis

Larkin Packer Company's sales force held a four-day meeting in St. Louis, Missouri, recently. In the picture are: G. F. Robinson, J. Morrison, J. A. Hill, C. F. Warner, J. B. Wetsel, I. P. Allen, D. O. Chism, J. J. Larkin, Jr., Dorothy Conkin, J. B. Hollingsworth, W. H. Larkin, R. B. Miller, A. Hokey, T. E. Alexander, F. S. Dewel, F. A. Proctor, G. E. Beeman, W. Ford, J. Meek, E. D. Curran, J. Brown, T. Michie, R. L. Ramby, F. E. Stevens, B. J. Jostrand, O. L. Wooten, F. Cook, J. C. Green, and P. N. Sullivan.

Consolidated Buys Airport

Future expansion of one of the most important industries in the Foothills area was indicated by the purchase of the Monrovia Airport, a 35-acre tract of land adjoining the southeast section of the city of Monrovia, as announced by Philip S. Fogg, president of Consolidated Engineering Corporation of Pasadena, California.

Consolidated Engineering at present operates two large plants in Pasadena, the main one being at 300 North Sierra Madre Villa in the Hastings Ranch district and the other at 620 North Lake Avenue; both will continue to function regardless of new developments.

Randolph and Smith Sail for South America

Thad Randolph, (below) vice president in charge of sales for Oil Base, Inc., and Elmer Smith, manufacturer's representative for Oil Base in South America, sailed from New Orleans recently, on

Alcoa Line's Corsair for Caracas. Both men visited oil fields in Venezuela and Randolph came back by way of Mexico City to visit with Gus Saavedra and Sam Lands, representatives for Oil Base, Inc., in Mexico. He will return early in April. Smith has returned to his headquarters in Caracas, Venezuela.

Dow Chemical Names Seven Distributors

Dow Chemical Company has announced seven distributing firms throughout the country to handle Methocel sales. On the West Coast sales will be handled by Braun-Knecht-Heiman, Braun Corporation, and Van Waters and Rogers Company. In the Midwest, Innis Speiden and Company, Inc., Merchants Chemical Company, G. S. Robins and Company, will distribute Methocel. In the East distributors will be Innis Speiden, J. J. Seidy and Company, and George Mann and Company.

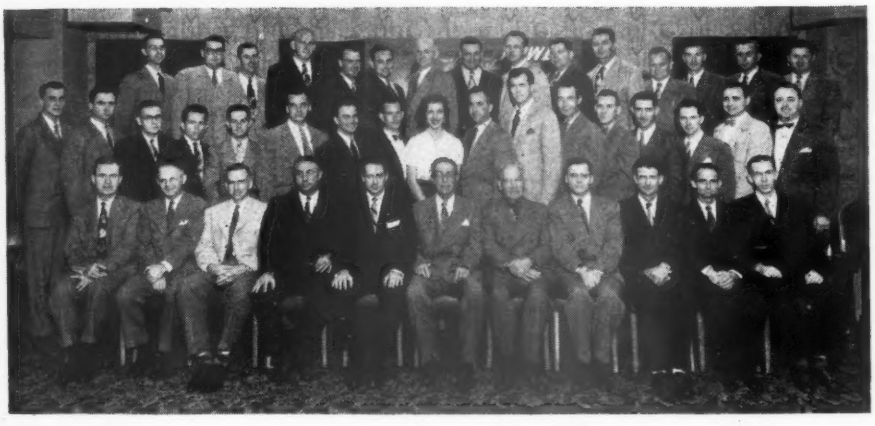
Happy Company Men Discuss Oil Industry Problems

Happy Company representatives from the Mid-Continent area met in Tulsa, Oklahoma, recently for a three-day session to study the problems of serving the oil industry.

Shown attending the meeting are: Front row: Ben Shelton, R. B. (Cotton) Rundle, Roy Lindley, John Mahaffey, Leo King, Ed Allan. Second row, Jack Simpson, Hayden Parrent, John Tinker, F. E. (Dusty) Rhoads, Harold Ashworth, E. L. (Bus) Williams, Orville L. Smith, W. H. Gorey. Third row, F. W. (Rowdy) Robson, Charles Stanley, L. E. Allen, Jim Lee, Murray Carr, John W. Ritter, Wiley Sweavenger.

Happy Company representatives discuss problems of serving the oil industry at meeting.

Oil Well Supply men at awards dinner.



In Houston, Texas, Waukesha salesmen at the annual meeting.

Waukesha Holds Meeting In Houston, Texas

Waukesha Sales and Service, Inc., held their annual sales meteing recently at the Ben Milam Hotel in Houston. Pictured, first row, are: H. A. Davis, district manager of Twin Disc Clutch; G. A. Duncan, branch manager, Waukesha Motor, Tulsa; C. O. Zagst, J. L. Kluppel, L. M. Pearce, Jr., president of Waukesha; L. M. Pearce, chairman of the board of directors; L. E. Hodges, W. A. Shalen, W. J. Buehring, Earl Gray, and B. Hall, all of Houston. Second row: H. D. Matthews, F. L. Wiley, S. W. Wacey, L. D. Lynch, all of Wichita Falls; Leon Miller of Pampa, Harry Goss, F. L. Williams, G. C. Shows, Ann Caldwell, I. J. Shay, Bert Coleman, all of Houston; J. B. Krenek and David Brey of New Iberia, Louisiana; James S. Warnick, George E. Swann, L. A. Bell, and George Axmacher, all of Dallas.

Third row: C. P. Cummings, F. M. McCarthy, J. T. Wilcheck, G. C. Sies, all of Odessa; Cecil Hobdy of Lubbock; Tom Jenkins of Snyder, F. A. Chance, M. D. Russell, Jim Ramsey, all of Kilgore; H. R. Schaumburg, Harold Sherrod, Shreveport; W. L. Jenkins, R. F. Park, Corpus Christi; O. E. Bishop of Pharr, Texas, and Austin Webb of Corpus Christi, Texas.

Pacific Ships Pumps

One of two horizontal single stage, double suction type Pacific centrifugal pumps is shown being loaded at the Burbank, California, airport. These pumps were designed and built by Pacific Pumps, Inc., for a large research

laboratory. Each pump will continuously remove 3,471,000 Btu per hour. In less than 48 hours after shipment, both pumps were set up and in operation at their East Coast destination.

Oil Well Men Honored At Annual Awards Dinner

Fred F. Murray, president of the Oil Well Supply division of U. S. Steel Company, pins 35-year service pin on Paul H. Shepherd at a recent service awards dinner in Dallas, Texas, honoring seven employees with 15 to 35 years service. Others pictured here who were honored are: W. F. Leer, Merle D. Routzon, N. C. Nasky, Murray, H. B. Medlin, Shepherd, and Alex Quayle. The seventh awardee, R. W. Rager, is not shown in the picture.

Babcock and Wilcox Plan Texas Plant

Babcock and Wilcox Company has begun construction on a new plant in Paris, Texas. This is the third new plant to be announced by the company within a year. The plant will employ 750 men when it gets into operation this summer Gay said, and will manufacture components for large utility and industrial boilers. Total area under roof in the new plant will be 135,000 sq ft composed of three bays 500 ft by 90 ft.

Myers, Fleetwood Promoted

Hughes Tool Company has created a new large division by combining the northern part of West Texas with the

P. L. Myers

C. W. Fleetwood

Wichita Falls district. Park L. Myers, formerly manager of the Ark-La-Tex division, has been promoted to manage the new "North Texas Division" with headquarters in Wichita Falls. He has been with Hughes since 1937. Clyde W. Fleetwood has been promoted to the managership of the Ark-La-Tex division with headquarters in Shreveport, Louisiana. Fleetwood has been with Hughes Tool Company since graduating from Oklahoma University in 1935.

Hammel-Dahl Names Central Texas Agents

Hammel - Dahl Company announces the appointment of Cowles and Company of Dallas, Texas, as its sales and service representatives in the central Texas area. Clifford A. Cowles, after graduating from the Georgia Institute of Technology, became chief engineer of the Atlantic Steel Company. In 1923, he organized Cowles and Company. Associated with Cowles and Company, as sales and service engineers, are Craig Millis and Dale Cunningham, both graduates of Southern Methodist University.

Mission Manufacturing salesmen at regular annual meeting in Houston.

Mission Sales Group Meets

The sales organization of the Mission Manufacturing Company recently gathered at the company's plant at Houston, for its regular annual meeting. The men are: Front row, O. K. Ryan, D. J. Ollre, Lonnie M. Roberson, F. S. Mims, R. E. Hardy, I. D. Abshire, Jack Bannister, Joe Scalise, R. M. Wood, E. L. Brown, Robert L. Creasy, J. H. Meek, S. L. Heidemann. Back row, left to right, A. E. Higginbotham, Charles W. Fryar, L. L. Roberson, Ted R. Fullinwider, Cobb L. Turner, D. E. Price, J. W. Holloway, Melvin C. Davis, R. L. Faris, W. T. Campbell, executive vice president and sales manager, Dudley C. Sharp, president, and J. E. Young.

Office Building Complete

L. E. (Larry) Heinen, president of Tube-Kote, Inc., has announced the completion of the company's new $50,000 office building on the grounds of the plant's 15-acre tract at 2520 Holmes Road, Houston, Texas. This new building brings to five the number of structures on the Tube-Kote lot. Among the features of the new building, which is of reinforced concrete construction faced with Roman brick and redwood, are rubber-tiled flooring, sound-absorbing ceiling, roll out partitions, and indirect fluorescent lighting.

Power Specialty Is Agent

Power Specialty Company, Inc., Houston, Texas, has been named by the Irving Subway Grating Company, Long Island City, as exclusive Texas Gulf Coast area representative. Power Specialty will handle the sales and servicing of stock for engineered open steel flooring requirements of the petroleum chemical, and manufacturing used in the petroleum field.

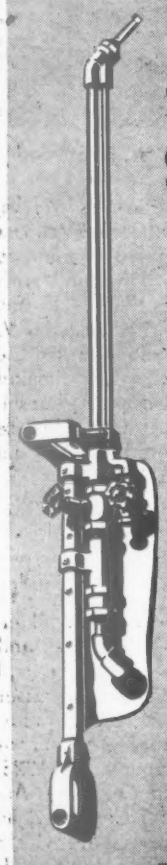
Corrosion Film Shown

A new, sound color film, prepared under the direction of the corrosion engineering section of The International Nickel Company, was shown for the first time at the annual conference and exhibition of the National Association of Corrosion Engineers at Galveston, Texas. Entitled "Corrosion in Action", this sound color film—which is in three parts of two reels each—shows how corrosion works to cause an annual loss in industry and elsewhere estimated at over six billion dollars. It also shows how this damage can be avoided.

Otis Sets Up New Branch

Otis Pressure Control has opened a new district office in Shreveport, Louisiana, at 1834 Jenkins Street with Ernest Fenton as operator-in-charge. The new office is under the supervision of Bob L. Crain, manager, Longview office.

Clean Equipment 50% faster with this Steam-Detergent Gun



YOU'LL clean up your plant in half the usual time with this Oakite 481 Steam-Detergent Gun and *only one man.* Gun quickly attaches to snuffer lines—blasts away soil, even from hard-to-reach areas. Lifts detergent spray up to 12 feet for high area cleaning. Tops for cleaning up around processing units, docks, salvage areas, machine shops, garages, power houses, pipe stills, decks, gridwalks, etc.

See it at work in your plant. Ask your local Oakite Technical Service Representative, or write Oakite Products, Inc., 48 Rector St., New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING

OAKITE

TRADE MARK REG. U. S. PAT. OFF.

MATERIALS • METHODS • SERVICE

Technical Service Representatives in Principal Cities of U. S. & Canada

Well Flooding

PUMPING STATIONS REFINERIES

Layne built well water supply units of extra heavy capacity offer a quick, efficient and modern method of well flooding to increase oil recovery. Installations in single or multiple units are easily controlled for normal or pressure flooding. Layne also makes installations for pipeline pumping stations, cooling and general purpose water for refineries, office air conditioning, fire protection and employee housing needs. All installations are made by Layne's own field crews. Complete information, catalogs, bulletins, etc., will be sent on request. Address

LAYNE & BOWLER, INC.

General Offices, Memphis 8, Tenn.

Layne WATER SUPPLY WELLS & PUMPS

New Orleans Office Opened

A combined regional office and warehouse has just been established at New Orleans, Louisiana, by Cooper-Bessemer Corporation. Operating under the direc-

T. E. Kraner

F. A. Gehres

tion of T. E. Kraner, branch manager, Cooper-Bessemer's new district facilities now provide direct factory representation for all engineering service requirements on engine and compressor applications. In addition, the new warehouse stocks essential parts for servicing marine and industrial installations currently operating in the Southern Gulf Coast area. Working directly with Kraner is F. A. Gehres, assistant branch manager.

Twin Disc Moves Into New Dallas Offices

The Twin Disc Clutch Company has moved its Southwest factory branch office and parts repair depot into new quarters at 1511 Turtle Creek Boulevard, Dallas, Texas, H. A. Davis, district manager, has announced. Construction was recently completed on the new Dallas building. The expanded facilities total some 10,000 sq ft.

Harry Peck has been appointed district sales engineer and will head the service department of the factory branch. Noble Brighton, transferred to Dallas from Twin Disc's Tulsa district office has been named branch manager.

New Ohio Plant Completed

The American Agile Corporation announces the completion of a new 12,500 sq ft building at 5461 Dunham Road, Maple Heights, Ohio. The expanded production facilities permit the manufacture of a complete range of standard and custom-built corrosion resistant bottles, containers, tanks, and tank liners, pipe lines, equipment, etc., in high-grade thermoplastic and thermosetting materials.

Rubber Latex Plant Set Up

A major expansion of facilities for the manufacture and sale of rubber latex and plastic materials on the West Coast, was announced by Naugatuck Chemical Division, United States Rubber Company. A new plant has been completed on Telegraph Road, Los Angeles, California, which will be the division's western sales headquarters. The plant will also contain customer technical service laboratories, facilities for the compounding and storage of natural and synthetic rubber latex, etc.

Bethlehem Men Meet In Tulsa, Oklahoma

Bethlehem Supply Company held its annnual managers' meeting in Tulsa, Oklahoma, recently. Simultaneously it formally opened the newly remodeled and redecorated lobby and first floor of its general office building at Second Street and Boston Avenue.

Management of Bethlehem Supply who participated in the meeting included: G. A. Tompson, president; C. R. Zimmerman, executive vice president; J. F. Eaton, vice president in charge of manufacturing; I. C. Smith, general manager of sales; H. R. Powers, assistant manager of sales; Christian Seger, Jr., treasurer; R. G. Petri, auditor and assistant secretary; W. B. Cotton, district purchasing agent; W. M. Sanders, manager of industrial and public relations; H. G. Evans, district traffic manager; V. W. Bailey, northern division manager; C. C. Crider, southern division manager; Lee Fagg; G. L. Reid; H. E. Davidson; H. A. Barnes; W. F. Taylor; H. A. Wilson; R. E. Dow; C. F. Carman, and D. L. Brown.

Bethlehem Steel representatives were: J. C. Miller, manager of sales, bolts, nuts, and sucker rods; N. R. Downie, manager of sales, wire rope and strand; E. A. Buxton, manager of sales, pipe and tubes; Gene LaSchober; L. C. Torell; J. S. Worth; W. J. Pearson; R. J. Gaines, and J. K. Lees, all from Bethlehem, Pennsylvania; B. C. Macgregor, general manager, central sales; G. W. Leslie, R. E. Burns, manager of sales, E. H. Gumbart, Jr., manager of sales, Chicago; J. E. Moore, general manager, southern sales, Houston; P. E. Anderson, manager of sales, Houston; B. C. Ramage, and F. E. Tuxworth, Houston. J. J. Lovell, resident representative; J. A. Dudley; R. L. Cooney; H. M. Cooley; N. B. Heywood, and J. E. Sultis, of Tulsa.

Bethlehem Supply, West Coast division men were Wendell M. Jones, vice president and general manager; and J. R. B. Freeman, general manager of stores.

Bethlehem Supply out-of-town personnel were: L. R. Estes, plant manager, Corsicana, Texas; Fred Parks, Houston; J. C. Knoll, Fort Worth; and F. R. House, Dallas, all resident managers; J. V. Spalding, Houston; and the following district managers: O. H. Crowe, Houston; W. J. Brady, Corpus Christi; J. B. Ellzey, New Iberia; J. G. Floyd, Shreveport; W. A. LeRew, Midland; W. T. Davis, Oklahoma City; E. S. Lewis, Casper; R. A. Johnson, Wichita; W. E. Stephenson, Wichita Falls; G. B. Sager, Salem, and H. S. Sutton, Pampa.

Freedom Award Given In Advertising Program

Freedoms Foundation of Valley Forge, Pennsylvania, has awarded The Youngstown Sheet and Tube Company gold medals for the second year in succession for the company's national advertising program and its employee magazine "The Bulletin." The awards were announced at Valley Forge. Basis for judging is the official credo of Freedoms Foundation which shows the American Way of Life based on a fundamental belief in God, constitutional government designed to serve the people, and an indivisible bundle of political economic creeds as set forth in the Constitution and Bill of Rights.

Bethlehem Supply men in front of remodeled general offices.

TRADE PERSONALS

Max T. Bruner, Refinery Engineering Company, has been named vice president in charge of field construction. Bruner's duties in his new capacity include inspection and supervision of all construction work in the field and their coordination with the home office in Tulsa. He has been with Treco since late in 1942, having been stationed in Ashland, Kentucky, and Chicago before being transferred to Tulsa in 1947. He became chief estimator in 1949.

M. T. Bruner

Henry P. Berry has been named southern regional manager for the Insul-Mastic Corporation of America. Berry has had considerable experience in the uses and proper application of these Insul-Mastic products. He was formerly an assistant to the chief insulation engineer of the Carbide and Carbon Chemicals Corporation.

Paul A. Newton was recently named East Texas district superintendent for Baroid Sales Division, National Lead Company. He will maintain offices in Tyler, Texas, for the firm, which supplies drilling mud products, mud testing equipment, and related services to drillers. Newton majored in science and mathematics at Upper Iowa University, and prior to his joining Baroid in 1946 had been a science instructor and a Navy navigation officer.

P. A. Newton

T. W. Painter, formerly supervisor of manufacturing, has been appointed operations manager for Welex Jet Services, Inc., originators of jet perforating. Painter is in charge of operations, which include Arkansas, Kansas, Oklahoma, Texas, Louisiana, and New Mexico. Painter is a licensed professional engineer, with a B.S. degree from the University of Idaho. He spent 10 years with Robert W. Hunt Company, consulting engineer firm in Chicago, and came to Fort Worth in 1947 as comptroller for Texasteel Manufacturing Company.

T. W. Painter

Harry C. Cochran was named sales representative for Toledo Pipe Tools in the Texas, Oklahoma, Louisiana, and Arkansas area. Cochran will make his headquarters in Houston, Texas, maintaining contact with distributors in the area. **Clifton E. Brokaw,** who represented Toledo Pipe Tools in this territory for several years, has resigned to go in business for himself in Dallas.

Charles O. Zagst, former district sales manager for Waukesha Sales and Service Company, Houston, Texas, has been named to the newly created position of manager of engine sales. Zagst joined Waukesha in 1949. Before joining the Waukesha organization, he was a field engineer for Shell Oil and later drilling superintendent for Austin Stewart Drilling Company.

C. O. Zagst

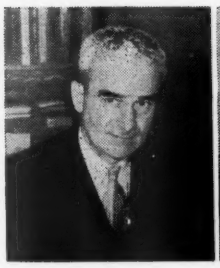
D. L. Wohlford has been named manager of the Snyder, Texas, store of the Oil Well Supply Division of U. S. Steel Company. Wohlford joined "Oilwell" in February, 1949, as a storeman in the El Dorado, Arkansas, store. He was transferred to Snyder in a similar capacity in 1950 and was later promoted to field sales representative at that city. He is a graduate of Texas A & M College.

H. J. Hagn

J. H. Robinson

H. J. Hagn has been elected president and a director of Chiksan Company. **W. Edgar Spear,** former president, has been advanced to chairman of the board, and **J. H. Robinson** has been elected a vice president of Chiksan Company and appointed general manager of Well Equipment Manufacturing Corporation, a division of Chiksan.

Hagn was previously vice president and general manager of Well Equipment in Houston, Texas. He joined this Chiksan division in 1937. Robinson became associated with Well Equipment as a salesman in 1940, and assumed administrative duties in 1942. In 1946 he became secretary and treasurer.



J. R. Steelman

E. A. Brugger

J. R. Steelman was elected president and **E. A. Brugger** vice president and general manager of Koehring Company.

In his new post, Steelman succeeds **G. E. Long** who will remain as chairman of the board of directors, a position he has held dually with the presidency up to this time. Steelman also will be elected president of each of Koehring's four subsidiary companies.

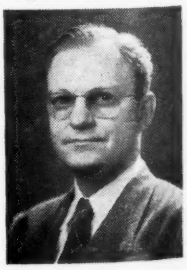
Brugger is a 35-year veteran with Koehring. After serving as assistant purchasing agent, during which time he organized the first Koehring production department, Brugger was named director of purchases in 1930 for Koehring Company and all subsidiaries. He was named vice president in charge of production of Koehring in 1948.

O. E. McCullough has been promoted to manager of Pittsburgh Coke and Chemical Company's protective coatings division. Formerly assistant manager of the division, McCullough will continue to maintain his office in Pittsburgh, Pennsylvania.

John B. Stephens has been appointed tubular manager of The National Supply Company's Gulf Coast division. Stephens has been associated with National Supply since 1939, when he entered the general sales office in Toledo, Ohio. In January 1943, he was transferred to Dallas, and four years later moved to San Antonio as sales office manager. He was assigned to Houston in 1949, as city salesman.

John B. Stephens

Dr. Clifford E. Berry, nationally known authority in the field of mass spectrometry, has been promoted to the office of assistant director of research at Consolidated Engineering Corporation. His particular distinction derives from his development of the Isatron, considered the heart of the mass spectrometer. He received his BS, MS, and PhD, from Iowa State College. Berry joined Consolidated in 1942 as research physicist, and became chief physicist.



C. E. Berry

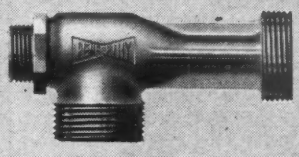
PENBERTHY *Jet Pumps*

(EJECTORS • EDUCTORS • EXHAUSTERS • SYPHONS)

Often the MOST ECONOMICAL and EFFICIENT WAY to Transfer and Mix Fluids

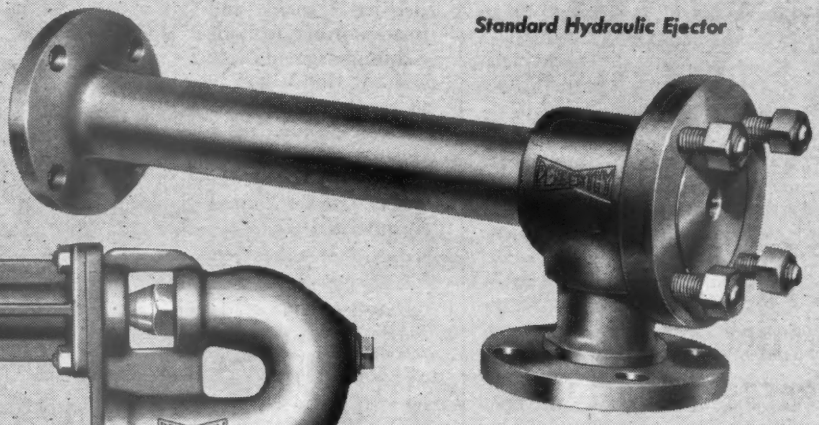
The jet pump is a simple device which uses steam, water or air under pressure to pump (or mix) fluids that can include solids in suspension. Jet pumps have no moving parts, need no lubrication, have no packing glands, are practically noiseless. They are low in initial cost and installation cost . . . compact in size and trouble-free. Penberthy offers a variety of jet pumps for a wide range of ordinary and unusual applications. They can be made from materials that withstand corrosion, contamination and high temperatures. Ask for new Bulletin 512.

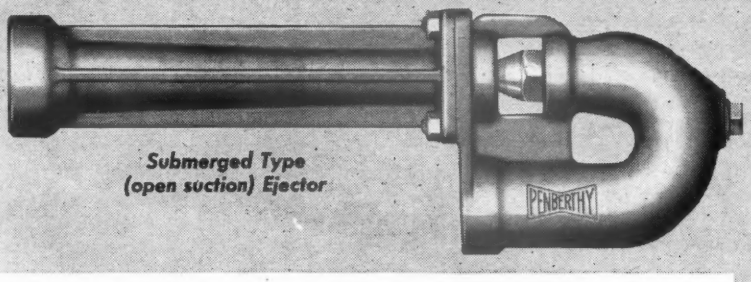
Standard Ejector for Steam or Air Operation



Standard Hydraulic Ejector

Stainless Steel Jet Pump for Handling Corrosive Chemicals

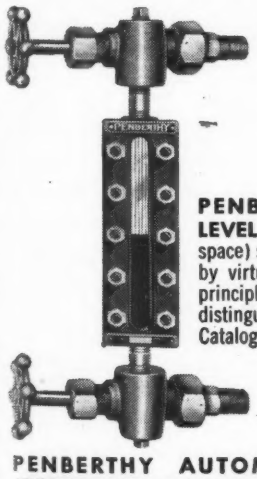




Submerged Type (open suction) Ejector

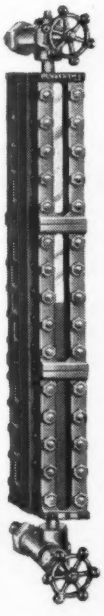
WRITE FOR *New* BULLETIN No. 512

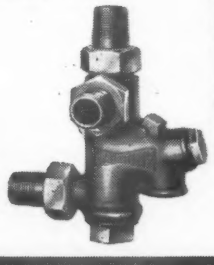
OTHER PENBERTHY PRODUCTS



PENBERTHY TRANSPARENT LIQUID LEVEL GAGE—Used to observe color and density of liquids under high pressures and/or temperatures. Exceptionally sturdy construction—liquid chamber machined from solid block of metal. Ask for Catalog 35.

PENBERTHY REFLEX LIQUID LEVEL GAGE—Empty space (or steam space) shows white and liquid shows black by virtue of a simple, unvariable optical principle. Accurate reading as far as you can distinguish black and white. Write for Catalog 35.





PENBERTHY AUTOMATIC INJECTOR—Will supply feed water to boiler at minimum cost. Quickly, easily installed, reliable under most severe operating conditions. Ask for Bulletin 513.

4731

PENBERTHY PRODUCTS

PENBERTHY INJECTOR COMPANY

DIVISION OF THE BUFFALO-ECLIPSE CORPORATION

Detroit 2, Michigan

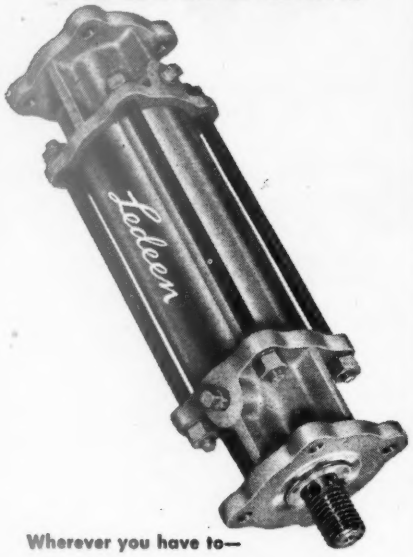
•

Established 1886

•

Canadian Plant—Windsor, Ontario

REPLACE COMPLICATED MECHANISMS WITH Ledeen CYLINDERS



Wherever you have to—

PUSH or PULL

LIFT or LOWER

PRESS or SQUEEZE

TILT or TURN

OPEN or CLOSE

Ledeen cylinders provide positive, dependable power and pressure in straight line motion. Designed for air, oil, or water operation, they are uniform in design and construction, affording a wide number of varieties and adaptations. Ledeen cylinders are easy to install, occupy minimum space, and are built for long, economical service.

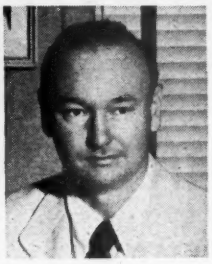
Standard Ledeen cylinders and mountings are available from distributors' stocks in major cities. Special cylinders if required. J.I.C., of course.

Ledeen Cylinders are GOOD Cylinders

Write for Bulletin 500

Ledeen Mfg. Co.
1608 San Pedro
Los Angeles 15, Cal.

R. D. Ford, Schlumberger Well Surveying Corporation, has been promoted to vice president and general manager of Schlumberger Surenco, which operates in South America. His headquarters will be in Caracas, Venezuela. He began his service with Schlumberger in 1936.



R. D. Ford

C. K. Ruddick

J. A. Bodin

C. K. Ruddick, has been made manager of the Mid-Continent area comprising Kansas and Oklahoma, with headquarters in Tulsa. Ruddick joined Schlumberger in 1936.

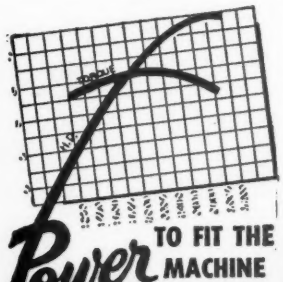
J. A. Bodin has been made manager of the newly created West Texas area, which is comprised of the Permian Basin and North Texas central divisions. The area office will be in Fort Worth, Texas. Bodin joined Schlumberger in France in 1933.

Carl W. Tuohey has been appointed as representative of The Frank G. Hough Company, for Hough sales district No. 2, comprising the states of New York, New Jersey, Pennsylvania, Virginia, Delaware, West Virginia, and New England. He will work with the Hough distributors in these states in the application of Hough "Payloader" tractor-shovels.

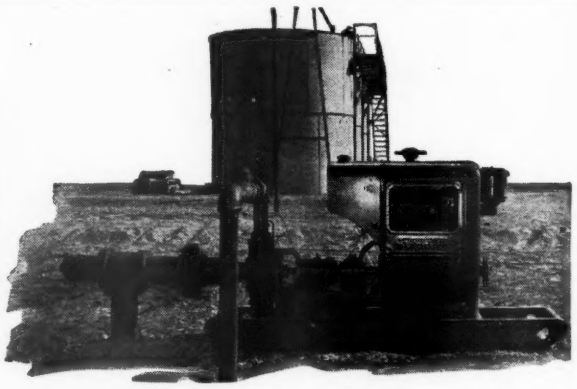
C. W. Tuohey

Douglas R. Kramer has been appointed advertising manager of the American Meter Company. An engineer, Kramer has been with American Meter since 1944. For the past few years he has been instrumental in the publication of the company's technical literature. He is an instructor in the measurement short courses held annually at the University of Oklahoma and West Virginia University. Prior to joining American Meter Company he was with Standard Oil Jersey.

D. R. Kramer



Power TO FIT THE MACHINE AND THE JOB



WISCONSIN-POWERED Oil Field Pump

When this pump bears down, 4,000 barrels of oil *come up* daily. It's powered by a 2-cylinder Wisconsin Heavy-Duty Air-Cooled Engine. And 56 more units like it have been ordered . . . ample proof of user-recognition.

The preference Wisconsin Engines *get* is preference they *merit*, due to these exclusive features. For example, the crankshaft rides on tapered roller bearings. Side- and end-thrusts are eliminated and there's no chance of bearing failure. Cooling, too, is best, summer and winter, when you depend on air alone. And, an OUTSIDE magneto with impulse coupling offers you more than easy servicing . . . you gain quick starts and steady running, any weather, under all conditions.

4-cycle single-cylinder, 2-cylinder and V-type 4-cylinder models, 3 to 30 hp.

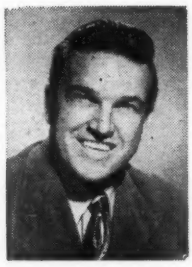
WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
619 S. MAIN STREET, TULSA, OKLAHOMA
M & M BUILDING, HOUSTON, TEXAS
505 SOUTH MAIN ST., WICHITA, KANSAS
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS.

D. E. Daffin

F. A. Rodgers

W. G. Gant



C. M. Schwab

A. H. Curran, Jr.

F. L. Bryan

D. E. Daffin has been named Gulf Coast area manager, Otis Pressure Control, Inc., in charge of the firm's service operations in south and southwest Texas, southern Louisiana, Mississippi, and Alabama. **F. A. (Jack) Rodgers,** also of Houston, has been appointed south Texas division manager, and **Guy Gant** south Texas division superintendent. All three men have several years' service with Otis.

Carl M. Schwab has been named service manager with offices at the company's headquarters in Dallas, Texas. Schwab studied petroleum engineering at Texas A & M for three years and was graduated from the University of Minnesota with a degree in engineering. He joined Otis in 1934.

Ralph G. Grant is now personnel manager for the Lane-Wells Company at Los Angeles. In this capacity, Grant will supervise all head office personnel activities, records, and welfare, and activities programs. Grant started for Lane-Wells in 1946 after five years of service in the Army. His previous position was that of sub-district superintendent at Harvey, Louisiana.

Lane-Wells has also established industrial relations departments in its Gulf Coast and Mid-Continent divisions. **Cecil R. Searcy** will be division industrial relations manager at Houston, Texas, and **Emmett C. Doane** will hold the same position at Oklahoma City, Oklahoma. Searcy and Doane will supervise all employee activities, welfare, counseling, working conditions, etc.

R. E. Bush, division sales engineer-geologist at Dallas, will handle the sales training program in the Gulf Coast and **R. L. Gregg, Jr.,** Oklahoma district sales engineer at Healdton, will assume the duties of sales training engineer for the Mid-Continent.

T. O. Liebscher has been named president of Le Roi Company. He joined Le Roi in 1940 as assistant secretary and assistant treasurer, then became secretary-treasurer. In 1946 he was elected to the board of directors and became executive vice president in 1950.

T. O. Liebscher

G. J. Hamm has been appointed secretary-treasurer, **C. W. Decker,** assistant secretary, and **J. R. Gavigan,** assistant treasurer.

W. S. Andrews has been appointed New York district sales manager for Rockwell Manufacturing Company. Andrews received a B.S. degree in business administration from the University of Pittsburgh. Upon graduation he joined the Nordstrom Valve Company as a salesman. He had been Pittsburgh district sales manager for seven years prior to his recent promotion.

Joe DonCarlos has been named field representative, Wheland Company, with headquarters in Wichita Falls, Texas. DonCarlos has had long experience with Wheland rotary drilling equipment. For the past 11 years he has been with Jones and Laughlin Supply Company. For 10 of those years he was with Jones and Laughlin organization, Wichita Falls.

J. DonCarlos

John T. Weber has been named manager—sales development, Cummins Engine Company, Inc., succeeding Howard P. Sharp, who resigned recently. Weber joined Cummins in 1947, and had served as assistant to the controller, until his new appointment. He holds a Bachelor of Science degree in business administration from Washington University, St. Louis, and also has a Master of Arts degree in business from Harvard Graduate School.

J. T. Weber

B. E. (Ben) Mater, Baker Oil Tools, Inc., is in South America for an approximately six-months' stay on Baker business. His itinerary includes both Eastern and Western Venezuela, as well as Colombia. His first stop is Maracaibo, from which base point he will cover the Western Venezuela fields in company with Baker Transworld's local representative, Lem Grubenman. The final leg of his present trip will keep Mater in Anaco, Eastern Venezuela, some four or five months, supervising construction of Baker Transworld's new warehousing and service facilities as well as residences for Orlan Webb and his staff. Mater plans to be back in August.

A. H. Curran, Jr., and **F. L. Bryan** have been appointed division managers of two new divisions formed by Schlumberger Well Surveying Corporation in California.

Curran has been named coast division manager with headquarters in Los Angeles. He and Bryan are graduates of the University of California. Bryan will be in charge of the newly created Valley division with offices in Bakersfield.

Serving as Ventura district manager is **C. R. Edgecomb, Jr.,** who joined Schlumberger in 1943, and was promoted to district manager in 1948.

G. C. Hepburn, Jr., newly appointed Long Beach district manager, joined Schlumberger in 1947.

Will Plasch has been made district manager at Santa Maria. Plasch became a field engineer for Schlumberger in 1946.

C. F. Gallagher, manager at Coalinga, has been with Schlumberger since 1946, assuming his present position in 1950. **Armour Kane,** Taft district manager, joined Schlumberger in 1943, was promoted to his present position on February 1, 1952. **D. G. Swiers,** with Schlumberger as field engineer since April, 1947, was made King City district manager at the same time.

C. B. Evans, Sacramento district manager, assumed his present duties in January after service since 1948 as field engineer in the Long Beach and Bakersfield districts. **J. H. Gallois,** Bakersfield district manager came to the U. S. as a member of the Schlumberger organization in 1925.

Thomas L. Blose has joined A. O. Smith Corporation of Texas as chief engineer at the company's Houston pipe mill. He comes from the Spang-Chalfant seamless tube mill at Ambridge, Pennsylvania.

G. J. (Gus) Meyer has been appointed advertising manager of Hughes Tool Company, Meyer joined Hughes in 1917.

G. J. Meyer

His first job with Hughes was in the company's general office. He next went to the shipping department, then to accounting. In 1927 he was transferred to the sales department and later became assistant to the sales manager.

PERRAULT
FIBER-CAST
THERMO-SET PLASTIC PIPE
REINFORCED WITH GLASS FIBERS
FOR
THE OIL INDUSTRY
THE GAS INDUSTRY
FRESH WATER SYSTEMS
SALT WATER SYSTEMS
"Everything for the Pipeliner"
★
PERRAULT Brothers
1130 NO. BOSTON,
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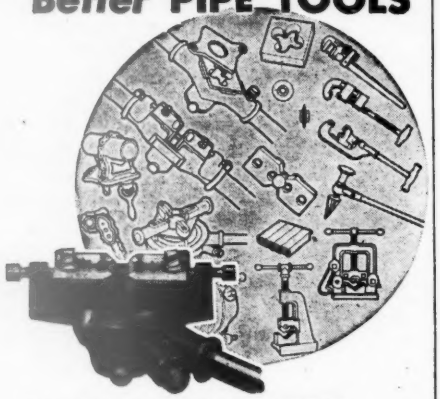
NEW YORK, N.Y.
CIRCLE 6-6260

ARMSTRONG BROS.
Better PIPE TOOLS



Reversible Ratchet STOCKS and Adjustable DIES

Exceptionally convenient where space is limited, this stock simplifies pipe threading close to walls, in corners and wherever operating room is restricted. With *adjustable* dies (cut exact, over or under size threads) it is an ideal tool where valves and fittings are being installed or maintained.

"ARMSTRONG BROS." Adjustable Dies are of special Vanadium Tool Steel, have "backed-off" teeth, correct cutting angle, ample chip clearance and correct throat angle. They start and cut easily, hold their sharpness and "spin" off pipe without jamming or tearing threads.

Write for Catalog

ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
5231 W. ARMSTRONG AVENUE • CHICAGO 30, ILL.

Tom Slick

E. M. Rees

A. M. Huffman

F. B. Crandall

Tom Slick has been elected to the board of directors of Dresser Industries, Inc. He is a partner in the Slick-Moorman Oil Company and Slick-Urschel Oil Company. Long interested in building a scientific research organization, Slick launched Foundation of Applied Research with the gift of a valuable oil property in the Tinsley field. He also founded the Institute of Inventive Research, and in 1927 founded the Southwest Research Institute. Slick is the son of the late Thomas Baker Slick, Sr., who at 20 brought in the Cushing oil field near Tulsa, Oklahoma.

Earl M. Rees has been appointed manager of export for the oil tool and PB divisions of Byron Jackson Company and BJ Service. Inc. Rees became affilated with Byron Jackson Company in 1946 when the Patterson-Ballagh Corporation became a wholly owned subsidiary.

J. R. Lewis has been appointed general sales manager of Quaker Rubber Corporation, Division of H. K. Porter Company, Inc. Lewis has been with Quaker more than 11 years. He has successively been Philadelphia district sales manager, assistant sales manager, and assistant general sales manager. He will be in complete charge of sales for the company.

B. A. Bauer has been appointed purchasing agent and supervisor of stores of the Oil City, Pennsylvania, plant of Worthington Pump and Machinery Corporation. Bauer was employed by the National Transit Pump and Machine Company for 30 years previous to Worthington's acquisition of the plant. During the period with National Transit he served in various capacities, among which were 16 years as purchasing agent. From 1948 until 1951, he served as secretary and assistant treasurer of the National Transit Pump and Machine Company.

William H. Sedgeman has been appointed manager of the anti-corrosion products division of Owens-Corning Fiberglas Corporation. Sedgeman joined the Fiberglas organization in 1938 as cost auditor after five years service in the comptroller's department of Owens-Illinois Glass Company. In his new post he assumes leadership of all research, production and sales activities of the anti-corrosion products division.

A. M. (Huffy) Huffman has been appointed sales engineer for Byron Jackson Company, and will be stationed at Casper, Wyoming. He will represent oil tool and PB divisions in the Rocky Mountain district. Huffman has had an excellent background in the oil industry. He spent 10 years with Standard Oil Company of California in the drilling and production department. In addition, he was with Drilling Exploration Company, for 11 years, five years of which were spent in Brazil. He has been with Byron Jackson since 1945.

Fred B. Crandall has joined T. D. Williamson, Inc., as development engineer, in its engineering department. Crandall is a graduate of Iowa State College. In 1948 he was employed by Phillips Petroleum Company, products pipe line department, as pipe line engineer. He resigned to enter the employ of T. D. Williamson, Inc.

J. N. McComb, controller, Goulds Pumps, was elected president of the Hydraulic Institute at its annual meeting at Absecon, New Jersey. **Britton L. Gordon,** president, Blackmer Pump Company, was elected vice president of the Institute.

C. W. Palmer has been appointed manager, Toledo plant products, National Supply Company. In his new position, he will be responsible for the direction of the planning, scheduling, and purchasing departments at the Toledo plant, as well as being responsible for commercial customer contacts. Palmer joined the company as manager of procurement for the Toledo division in 1943.

C. W. Palmer

Emil H. Balz has been appointed director of research of Glass Fibers, Inc. In the past, Dr. Balz has served as both a consultant to the glass concern and had charge of the glass and plastic laminate laboratory. It was under his direction that the "Vitron" continuous glass cloth treating process was developed at the Waterville, Ohio, plant of the company. Dr. Balz received his B.S. and MS degrees from Ohio State University and his doctorate of philosophy from the University of Pittsburgh.

Sabel E. Baum, Dixie Engineering Company, Birmingham, Alabama, has been appointed district representative of the Dollinger Corporation in Ala-

S. E. Baum

R. A. Stipp

bama, Western Florida, and Marion, Hamilton, Bradley, and Polk counties, Tennessee. He was graduated from Alabama Polytechnic Institute as a mechanical engineer. **Roy A. Stipp** has been appointed district representative for North Carolina, South Carolina, and Eastern Tennessee.

R. S. Sweeney, vice president and treasurer has been elected a director of Watson-Stillman. **James W. West, Jr.,** a director of the company, has been appointed assistant to the president; **A. B. Diss,** has been appointed vice president in charge of manufacturing; **R. W. Dinzl,** consulting engineer; **Adolph de-Matteo,** chief engineer; **R. W. Schreck,** general manager of sales, hydraulic division; **Jackson Kemper,** general manager of sales, distributor products division; **Herbert E. Elliott,** sales manager, hydraulic division; **John P. Bittenbinder,** sales manager, distributor products division; **Walter R. Biedermann,** industrial engineer; **Elsworth Falkenberg,** plant manager; **Eric Nelson,** plant superintendent, and **A. Walters,** production manager, hydraulic division.

West and Diss are Yale graduates and Biedermann and Kemper are graduates of Cornell and Hobart respectively. The company also has added to its hydraulic sales department **Richard M. Norman,** a graduate of Georgia Tech.

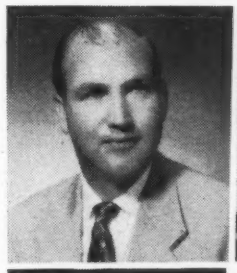
Alwin F. Franz was elected president of The Colorado Fuel and Iron Corporation. **Carl M. Myers,** who has been president of Colorado Fuel and Iron since 1946, was elected vice chairman of the board of directors.

A. F. Franz

Ernest W. Wilhelm recently returned from a 12-month tour of major refineries in Great Britain and Continental Europe in the interest of customers of Pacific Pumps, Inc. He also spent time in Europe with Pacific licensees.

Donald T. Fowler has been named advertising manager of Baroid Sales, Division, National Lead Company, Houston. Experienced in the oil industry since 1940, Fowler has been associated with Axleson Manufacturing Company, Byron Jackson Company, and Lane-Wells Company before joining Baroid. He was educated at the University of Southern California.

D. T. Fowler



J. M. Bugbee, Jr.

L. W. Jones

L. W. Jones was recently promoted to the position of export manager at Baroid Sales at Houston, Texas. He joined Baroid in 1946 as a mud engineer.

James M. Bugbee, Jr., has been transferred to the advertising department of Baroid Sales to assist in the preparation of the firm's technical publications relating to drilling muds, well logging, etc.

Business and Pleasure in TULSA means-

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★ CENTRALLY LOCATED

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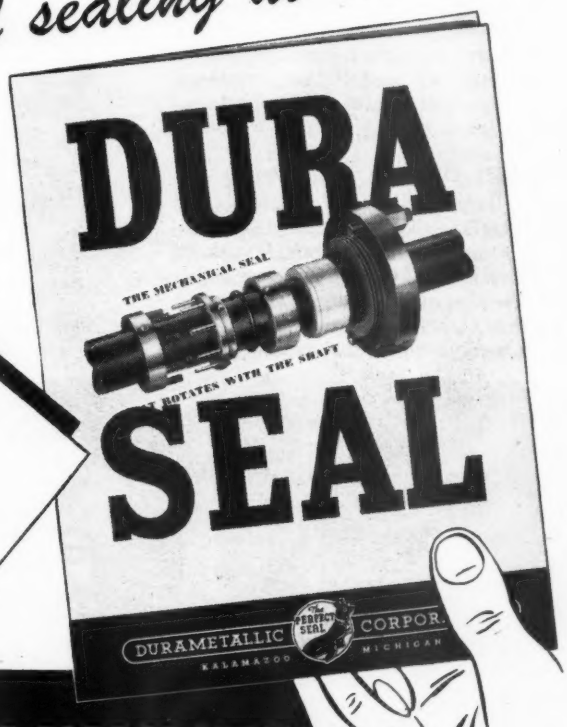
DURA SEAL means mechanical sealing at its best!

... provides superior sealing for refinery processing and pipe-line pumps ...



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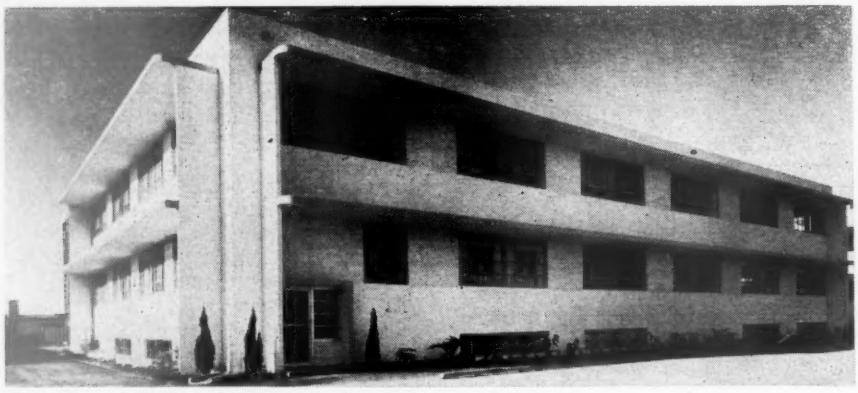
DURAMETALLIC CORPORATION

KALAMAZOO, MICHIGAN

Oil Center Tool Store. A new warehouse store serving North Louisiana, East Texas, and Mississippi, has been opened in Shreveport, by Oil Center Tool Company. H. C. Stewart is district manager.



New Fluor building designed by W. J. Moran Company.

Fluor Building Complete

Fluor Corporation has just completed construction on a new building at 2500 Atlantic Avenue, East Los Angeles.

The structure will serve as an engineering and drafting office for Fluor, and features the latest developments in air conditioning and lighting systems, and exceptional qualities of sound and thermal insulation.

Houston Branch Opened

The Refinery Supply Company of Tulsa, Oklahoma, announces the opening of a branch in Houston, Texas, at 2215 McKinney Avenue. The new structure provides about 8000 sq ft of space for offices, stockrooms and warehouses with adequate room for expansion.

Bronzan Gets Promotion

B. Bronzan has been named vice president and general manager of the Adel division, General Metals Corporation. His previous experience includes early training with the Union Iron Works — later Consolidated Steel — and from 1929 until the first of the year he has been associated with the Baash-Ross Tool Company as general manager. He has travelled extensively in the interests of the companies with whom he has worked.

B. Bronzan

Refinery Supply Company's newest branch, situated in Houston, Texas.

Oakite Moves Offices

Oakite Products, Inc., have announced the transfer of the company's general offices from 22 Thames Street to newer and larger quarters at 19 Rector Street, New York 6, New York. Contributing to the move, have been the increased use of Oakite cleaning and related materials by industry and the steadily growing demand for technical advisory service and special research.

Republic National Bank Building in Dallas has been given two additional floors. First structural steel for the new building has been placed into position by American Bridge Company, and it is expected this phase of construction will be completed about May 1.

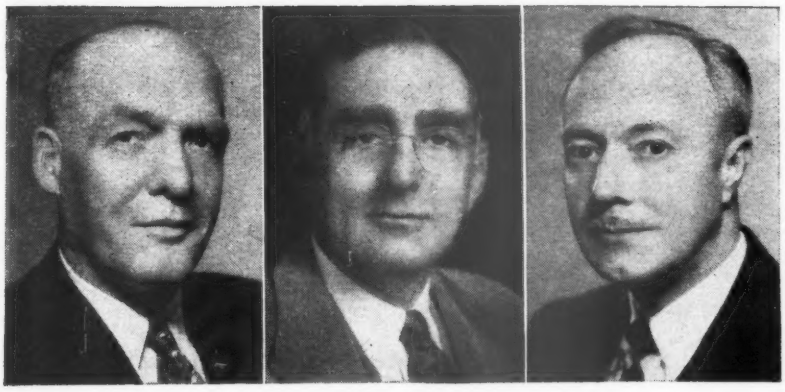
Wing Goes to Main Office

Benny Wing, formerly manager of the Eastern division, Fluid Packed Pump Company, has been transferred to the main office at Los Nietos, California, to head the newly created merchandising department. M. B. Curtis, formerly division engineer at Tulsa, Oklahoma, is now manager of the Eastern Division at Olney, Illinois. Grady Jenkins, formerly district representative at Seminole, Oklahoma, is now division engineer at Tulsa.

Benny Wing

Gordon Satterla, formerly connected with the main plant at Los Nietos, is division engineer for West Texas, stationed at Odessa, Texas.

Ben Hamilton, formerly with Darling Valve Corporation, has joined the sales force as district representative for the Texas Panhandle at Pampa, Texas.



D. S. Jeppson M. T. Higgs R. M. Otis

Morton T. Higgs and **Dr. Russell M. Otis** have been elected vice presidents of Lane-Wells Company, according to an announcement by Rodney S. Durkee, president. **D. S. Jeppson,** vice president, has been given added managerial responsibilities; **L. H. Ingle** has been appointed controller, and **V. L. Forsyth** has been made chief engineer.

Higgs has been in the petroleum industry since 1916, the first 14 of these years with prominent oil companies as a geologist. He was with the Sperry-Sun Well Survey Company as Gulf Coast regional manager for eight years before joining Lane-Wells in 1938.

Dr. Otis, as vice president in charge of engineering, research, and patents, is responsible for all phases of Lane-Wells engineering and research. A graduate of California Institute of Technology, Otis joined Lane-Wells as a research engineer in 1941.

Jeppson, senior vice president, has relinquished his duties as controller to L. H. Ingle who was his assistant.

Barney N. Dagan has been named assistant general superintendent of the Kaiser Steel Corporation plant; **Clarence R. Lohrey,** division superintendent of iron and steel, and **William G. Schulze,** superintendent of coke ovens and by-products. In his new position, Dagan, formerly division superintendent of iron and steel, will be responsible for the operations and services divisions at the Fontana works. He is a graduate chemical engineer from Ohio State University in 1936.

Lohrey, who is taking the position of division superintendent of iron and steel, has been at the plant since 1947 as assistant superintendent and superintendent of the coke ovens and by-products. He was graduated as a chemical engineer from the University of Cincinnati, Ohio, and came to Kaiser from the Corregan-McKinney Works of Republic Steel.

Schulze was promoted from assistant to full superintendent of the coke ovens and by-products.

L. C. Holloman, Hewitt-Robins, Inc., was recently put in charge of sales in the south central area for both the Hewitt Rubber Division and Robins Conveyors Division. His headquarters will be 1206 Valasco, Houston, Texas.

Carl A. Salmonsen has been appointed general manager of the General Electric Company's newly-formed industry control department. The new department, with headquarters in Schenectady, New York, will be a component of the switchgear and control division. Salmonsen, a G-E employee for more than 42 years, has been manager of manufacturing of the company's former large apparatus division. He was named to his most recent position in 1949.

Herman H. Miller, retired the end of February after serving 50 years with Worthington Pump and Machinery Corporation. In 1901 as an application engineer he joined the Laidlaw-Dunn-Gordon Company of Cincinnati, Ohio, a subsidiary of International Steam Pump Company, which later became Worthington Pump. Ten years later he became manager of the air compressor department at Worthington's New York office and in 1915 became sales manager of Worthington's Cincinnati, Ohio, plant.

H. H. Miller

George Karnofsky, inventor of the Rotocel extractor, has been appointed assistant to the director of research for Blaw-Knox Company's Chemical Plants Division. Karnofsky joined Blaw-Knox in 1943 and has been active on the research staff of the company's fabricating division at Blawnox, Pennsylvania.

John W. Hubbard, who joined the company recently, will supervise the division's building activities for the oil and gas industries and for the process industries generally in the southwest. Hubbard attended the University of Oklahoma and has had extensive experience as a superintendent of oil field and refinery construction projects. He will make his headquarters in Tulsa.

Other appointees are **Herbert Morgan, Jr.,** and **J. C. Tooke,** both of whom will have their headquarters in Pittsburgh.

Before joining chemical plants division, Morgan was a resident engineer on construction projects. Tooke and Morgan are graduates of Carnegie Tech.

Frank S. Carothers has been re-elected president and general manager of the Norvell Wilder Supply Company.

Eugene T. Thompson was re-elected vice president and secretary, **E. W. Gildart,** vice president and **Frank A. Douglas,** treasurer. Douglas was also named assistant secretary and was elected to the board of directors. Carothers had been a vice president of the company for more than 20 years, in charge of the company's Houston branch, before his election to the presidency two years ago.

Miles W. Burleson has been named assistant manager for the insulation department, Johns-Manville Industrial products division. He joined Johns-Manville in 1936 as assistant engineer for the company's industrial products division at Chicago, and subsequently, became district engineer and Chicago district assistant staff manager for insulations. In 1950 Burleson was transferred to division headquarters in New York City, where he has been a staff manager in the insulation department.

C. D. King has been named assistant vice president and chairman-engineering committees, United States Steel Company. King was graduated from the Sheffield Scientific School of Yale University in 1914. He joined U. S. Steel the same year as a metallurgist at the Clairton Work's of Carnegie Steel Company, and was named chairman, open hearth committee.

C. D. King

Arthur Templeton has been appointed Southwestern divisional sales engineer for Templeton, Kenly, and Company. He will make his headquarters in Dallas, Texas, to cover the states of Texas, Oklahoma, and Louisiana. Son of the company's founder, Templeton will be working primarily with Templeton, Kenly distributors serving Simplex jack users in the oil fields. He has served the company for the past two years as a sales engineer in the Chicago area and, prior to that, spent four years in the production department.

Milton J. Weber has been named vice president, procurement, of the Frank G. Hough Company. A graduate of DePauw University, Weber joined Frank G. Hough from J. D. Adams Company where he held the position of office manager of the St. Louis Branch. At Libertyville, he immediately took over the control of the purchasing and priority functions for the Hough Company.

M. J. Weber

DOWN GO
MAINTENANCE COSTS

SAND-BANUM SPECIAL

TABLETS REMOVE AND PREVENT RUST AND SCALE IN ALL RADIATOR COOLING SYSTEMS

Fully Effective Regardless of water or Operating conditions

SAND-BANUM

REMOVES AND PREVENTS BOILER SCALE AND CORROSION

USE OUNCES ONLY ONCE A WEEK

Increased Efficiency
Longer Equipment Life
Reduced Fuel Bills

Stocked by Leading Supply Houses

AMERICAN SAND-BANUM CO.
Established 1926
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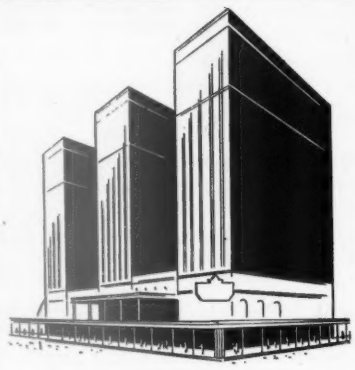
New York 20, N.Y.



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- Completely air-conditioned.
- Businessman's hotel in heart-of-Houston location.
- Four fine restaurants, excellent cuisine
- Famous Empire Room, nationally known orchestras, playing noon and night
- New 1,000-car garage
- Fabulous new PETROLEUM CLUB, entire top floor.
- Room rates: from $4 single, from $6 double

B. F. ORR, *General Manager*

The Rice Hotel

HOUSTON • TEXAS

Kendall B. May, The Trenton Corporation, has been named head of product development and technical service. Before joining Trenton, May was operat-

R. W. Rankin

K. B. May

ing supervisor for Ethyl Corporation; plant superintendent with Dow Chemical, Freeport, Texas; and refinery superintendent for Pure Oil, Midland. Michigan.

Robert W. Rankin, was named sales and service representative covering Canada and the central and southern United States out of the Ann Arbor, Michigan, office. Rankin was formerly a sales engineer with International Oil Equipment Company.

L. G. Fox, formerly manager of wholesaler sales, has been transferred to manager of sales service, Wolverine Tube Division of Calumet and Hecla Consolidated Copper Company.

S. C. Seekell, who has been in charge of Wolverine's Grand Rapids sales office, has been appointed manager of wholesaler sales. Both men will have headquarters at the company's general sales offices, Detroit, Michigan.

J. A. Jolly will be responsible for Wolverine's sales in western and northern Michigan. He is being transferred from the Milwaukee sales office, and will replace S. C. Seekell in Grand Rapids.

D. M. Irwin, formerly affiliated with Allis-Chalmers Manufacturing Company, has completed his training program with the division, and will be in charge of sales in Milwaukee.

George T. "Tuck" Stainback, Jr., has joined the Strata-Crete division of the Great Lakes Corporation. Formerly with Brown Drilling Company, Stainback was also a professional baseball player with 13 years in the majors.

G. T. Stainback

James C. Skakel has been named president of Great Lakes Corporation. He has been associated with Great Lakes Carbon since 1934. His headquarters will be in New York City. The board of directors has also announced that **R. M. Cook** has been elected to the office of vice president in charge of sales of Great Lakes Corporation.

Great Lakes also announces that **James T. Hancock** of Houston, Texas has joined the company as regional manager with offices in Houston.

James A. Hale has been appointed district sales manager in charge of the Cleveland office for The Youngstown Sheet and Tube Company, succeeding **F. A. (Ted) Olmstead** who died recently.

Russell C. C. Dubois, Jr., has been appointed sales manager for RCA mobile and microwave communications equipment, RCA engineering products department. Since 1950, Dubois has been field sales coordinator for mobile communications equipment. Prior to that he served as a sales engineer for RCA broadcast and television equipment and the RCA Tube Department. He joined the company in 1946. He is a graduate of Rhode Island State University.

Richard Meisenbach, director of the special products division of J. B. Beaird Company, Shreveport, Louisiana, has been appointed a branch chief in the engine and turbine division of The National Production Authority in Washington, D. C. He will be loaned to the federal agency by the Beaird Company for a period of six months. The branch, which Meisenbach will head, includes sections concerned with the manufacture of tanks, heat exchangers, fabricated metal piping, and water softeners.

R. Meisenbach

Max Hofmann, Waukesha Motor Company's export sales manager, is in South America to visit export sales distributors there who sell Waukesha engines and power units. He stopped in Mexico and Panama en route to Bogota, Colombia. From Bogota he will travel to Ecuador, Peru, Chile, Argentina, Brazil, Venezuela, and Puerto Rico, and return to the United States this month.

Max Hofmann

James B. Hoxie has been named Western division sales manager of Oliver United Filters, Inc., with headquarters in Oakland, California. His territory takes in all the Mountain and West Coast states. Hoxie, who has been with the company 20 years, succeeds **Philip J. McGuire** who has been appointed director of research and development.

L. L. Winters was recently appointed district drilling equipment representative for Continental Supply Company at Shreveport, Louisiana. Winters will concentrate on the sale of drilling equipment in Arkansas, Northern Louisiana, Mississippi and East Texas. His position prior to this appointment was store manager at Natchez, Mississippi.

J. S. Ewing

P. F. Voigt

John S. Ewing has been named as manager—stainless steel sales, United States Steel Company. He succeeds **Paul F. Voigt, Jr.,** who is retiring after 16 years with U. S. Steel and 42 years in the steel industry. Ewing was graduated from Princeton University with a B.S. degree in engineering. He joined U. S. Steel in 1936 as a salesman for Carnegie-Illinois Stainless Steel Division in Chicago. Voigt is widely known throughout the steel industry as one of the pioneers in the manufacture and use of stainless steel.

Willard deCamp Crater, Jr., has been appointed chief of the thermoplastics section, chemical division, National Production Authority in Washington, D. C. Crater who is the assistant manager of vinyl sales for the Naugatuck chemical division, United States Rubber Company, has been given a leave of absence by the company in order to assume the government post.

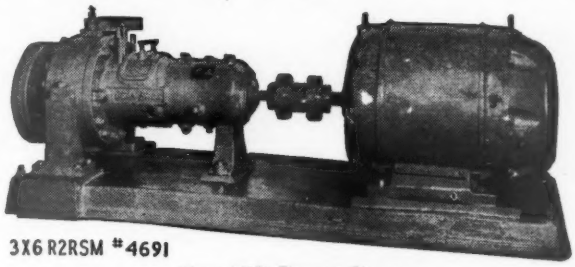
Dr. George O. Curme, Jr., has been elected a director of Union Carbide and Carbon Corporation to succeed the late James A. Rafferty, vice president and director. Dr. Curme, as vice president, is in charge of all research activities of the corporation. He has been honored by many awards for his accomplishments in the field of chemistry—the Chandler Medal by Columbia University in 1933; the Perkin Medal of the Society of the Chemical Industry in 1935, and many others.

G. O. Curme, Jr.

D. V. Clemons has been promoted from salesman at Lake Charles to district manager of the Louisiana Gulf Coast district with offices in New Orleans, for Cameron Iron Works, Inc., Houston. Other personnel changes announced by Cameron include the transfer of **J. M. O'Neill** from the Houston sales department to the position of sales representative at Williston, North Dakota. **Bill Watson,** former WKM representative in West Texas, has joined the Cameron West Texas division as salesman in Odessa. **M. E. Decker,** formerly with Halliburton Oil Well Cementing Company in Oklahoma, has also joined the Cameron sales staff and is stationed at Vernal, Utah.

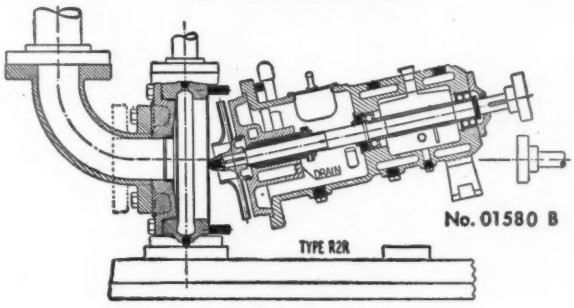
DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



3X6 R2RSM #4691

Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

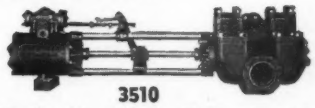
OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute.
Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

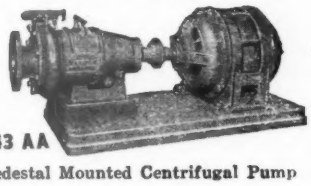
4040H

Close Coupled Centrifugal Pump



3510

Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

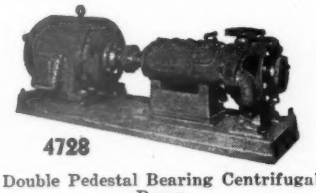


4043 AA

Pedestal Mounted Centrifugal Pump

3833

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



4728

Double Pedestal Bearing Centrifugal Pump

3556

Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

T. N. Shults

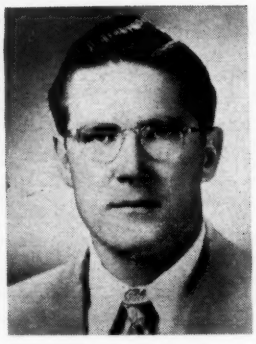
M. L. Hancock

A. Z. Day

J. E. Ryan

B. J. Hickman

F. M. Wilson



G. A. Metz

B. S. Harkrider

T. F. Schmidt

T. R. Fleeman

▸ **T. N. Shults** has been appointed export manager for Mid-Continent Supply Company's New York division office. He was graduated from Texas A. & M. College and employed by Mid-Continent in 1939. Since 1947, he has been in New York as export sales engineer and assistant export manager.

Billy J. Hickman has been promoted to store manager at Duncan, Oklahoma. He attended Oklahoma University before going to work for Mid-Continent in 1948 at Duncan. In 1950, he was promoted to store manager at Elk City, Oklahoma, where he remained until his recent transfer to store manager at Duncan.

Max L. Hancock, Mid-Continent Supply field salesman Odessa, Texas, has been named store manager at Hobbs, New Mexico. Hancock first went to work for Mid-Continent Supply Company in 1948, at Sundown, Texas. In 1951 he assumed new duties as field salesman at Odessa, Texas.

A. Z. Day is new store manager in Sterling, Colorado. He joined Mid-Continent in 1948. In June of the same year, he was transferred to Fullerton, and moved to Casper, Wyoming, as field salesman in 1950.

John E. Ryan, former field salesman at Hobbs, New Mexico, has been appointed Oklahoma City store manager. He began working for Mid-Continent in the Kermit store in 1949. He was transferred to Hobbs in September of that year and was promoted to field salesman in Hobbs in 1950.

F. M. Wilson has been promoted from field salesman at Elk City, Oklahoma, to store manager at the same location. Associated with Mid-Continent Supply since 1948, Wilson was first employed in the Pauls Valley store. In 1950, he was transferred to the Elk City store when it was opened.

Gilbert A. Metz has been named district machinery manager in Casper, Wyoming. Metz was graduated from Rice Institute in 1945, joining Mid-Continent in 1946. He was transferred to Fort Worth as machinery salesman in 1950, and was made manager of the quotations department in 1951.

Ben S. Harkrider is new district manager at Wichita, Kansas, for Mid-Continent Supply. He has been associated with Mid-Continent since 1937. In 1940, he became store manager at Magnolia, and was later transferred to store manager at Duncan, Oklahoma.

T. F. Schmidt has been promoted from Mid-Continent's Houston store to store manager at Falfurrias, Texas. He studied mechanical engineering at the University of Houston, joining Mid-Continent in 1948. He went back to Houston from Falfurrias in 1951 as telephone sales and unit rig parts man.

Tommie R. Fleeman, field salesman at Snyder, Texas, has been promoted to store manager there. He replaces **C. D. Melver,** who has been transferred to Abilene, Texas, as store manager. Fleeman attended the University of Texas and was first employed by Mid-Continent in 1947. In July of 1949 he moved to the Snyder store.

▸ **Ross R. Chenault,** associate of D. T. O'Connor, export representative, is on an extended trip in South America, visiting all of the oil production areas in the South American countries on behalf of the: Shaffer Tool Works, Frank Wheatley Pump and Valve Manufacturers, M. J. Crose Manufacturing, Mayhew Machine and Supply, Drilling and Service, Inc., Mud Products, Inc.

▸ **Arthur F. Dries,** Gar Wood Industries, Inc., has been named manager, sales promotion and advertising. He is in charge of the corporation's central advertising department, which handles all sales promotion and advertising functions for Gar Wood's Findlay, Wayne, St. Paul, Richmond, and national lift divisions as well as the Gar Wood branch offices in major cities throughout the country. **Guilford E. Koehler** has been appointed district manager at Memphis, Tennessee for Gar Wood Industries, Findlay division. Koehler worked as a Gar Wood serviceman for more than nine years and has been a district manager for the Findlay division. **William H. McAllister** has just been appointed Gar Wood district manager, Findlay division.

▸ **R. W. Stetson,** formerly a member of Dowell Incorporated's Eastern Seaboard sales organization, has recently joined the cathodic protection sales group, magnesium department, The Dow Chemical Company. He is a specialist in marine engineering, holding an unlimited license as Chief Marine Engineer and a Commander's commission in the U. S. Maritime Service. He will specialize in magnesium anodes for marine use.

▸ **William M. Wallace** has been appointed assistant to the vice president of Allis-Chalmers general machinery division. Since 1947, Wallace has been special assistant to G. V. Woody, manager of the company's processing machinery department. He entered Allis-Chalmers employ in 1937 after graduation as a mechanical engineer from Alabama Polytechnic Institute. **Elvin R. Danielson** is head of priorities succeeding the late **Robert T. Ward.**

New Machinery and Supplies

Use reply card to procure promptly complete information and prices of products described here in brief.

Circle corresponding letter or letters on reply card.

(A) SILENCING EQUIPMENT

Burgess-Manning Company has developed equipment that will reduce airborne air compressor intake noise, it has been announced. Three "snubber" series have been designed, it was stated, which also will meet pulsation problems. A company spokesman said the silencing equipment has been prepared to apply to any type and size of compressor and to meet all needs of silencing requirements ranging from noncritical industrial locations to highly critical applications such as residential areas, hotels, theaters, and hospitals.

Circle letter (A) on reply card.

(B) ENGINES

A new and compact, high horsepower engine has been announced by Kohler Company. The new engine, Model K90, is a power plant with a 3.6 hp rating at 3600 rpm. It weighs only 44 lb. The K90 mounting dimensions permit using it on present equipment as replacement for existing engines. It is adaptable to scores of engine-power applications. Among the features of the K90 are anti-friction ball bearings at both ends of the crankshaft, easily accessible breaker points that are dustproof and moistureproof and externally mounted for speedy servicing. The ignition system operates from a high voltage crankshaft magneto that insures instant starting.

Circle letter (B) on reply card.

(C) CRAWLER CRANE

American Hoist and Derrick Company announces a completely new ¾ yard crawler crane, available with a choice of fronts—crane, shovel, dragline, or pull shovel. This new machine reflects the experience gained from almost three-quarters of a century of building excavating machinery. The Model 375 BC, as the new unit is called, follows the same basic "American design" used in their huge 80 ton capacity locomotive crane and 100 ton revolving crane in that the machinery platform is an integral rolled steel electrically welded unit, rather than the conventional cast center with bolted-on walkways. It definitely falls in the heavy duty 45,000 lb class. Track pads are double walled, special steel castings, with full length pins.

Circle letter (C) on reply card.

(D) ROD CLAMP

A new polish rod clamp has been developed by the J. M. Huber Corporation. Though small, the Huber No-Bolt clamp features a unique wedging action that tightens its hold on the polish rod as the load is increased. It has been successfully tested on loads up to 126,000 lb, according to the manufacturer. Because there are no bolts to tighten, the clamp is easily installed and adjusted. By using interchangeable slips, the Huber No-Bolt clamp can be adapted to any standard size polish rod. It is rustproof and highly corrosion resistant in all exposures. Overall weight of the clamp is 11 lb.

Circle letter (D) on reply card.

(E) WATER PUMP

Especially designed and built to meet the exacting demands of oil field service is the Wichita water pump, which is a 2-in. centrifugal enclosed impeller type. Its shaft is covered with a thick layer of stainless steel under the packing gland. It is more wear resistant that the steel shaft or a brass sleeve. The suction pipe is 2½-in. and the discharge pipe 2-in. Capacity at 30 lb is 250 gal per minute at 1800 rpm. Pump can be provided with shaft extension for direct motor drive or with V-belt pulley keyed to shaft.

Circle letter (E) on reply card.

(F) SPEED UNITS

Sterling Electric Motors, Inc., announces the addition of Type KFEA variable speed units with single reduction gears in ratings of 20 and 25 hp. These units are manufactured in speeds of 728 rpm and lower with infinite speed adjustment within the ranges of 2:1, 3:1, or 4:1. Features of the drive are: Positive adjustment of pulleys, accurate maintenance of speeds under varying loads, belt tension in proportion to load, positive oil seals, and many others.

Circle letter (F) on reply card.

(G) AUTOMATIC CONTROLLER

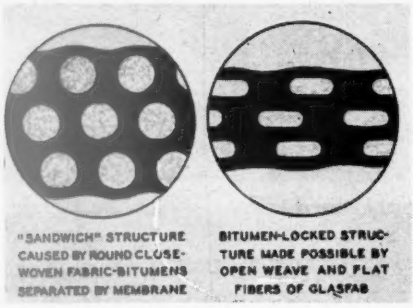
Builders-Providence, Inc., has announced the availability of the APC—automatic program controller a device for controlling the feed of chlorine at predetermined rates for predetermined periods in identical cycles to meet variations in chlorine demand as they may occur. The controller consists of a simple, cam-operated pressure valve so arranged as to transmit varying pressures to the lower diaphragm pressure chamber of the chlorine control valve in a Chlorinizer. The cams are interchangeable with ease to meet the many variables encountered in chlorine demand and dosage.

Circle letter (G) on reply card.

American Hoist and Derrick Company's latest crawler crane.

(H) GLASS FIBER

A new fabric called Glasfab has been introduced by the Twinsburg-Miller Corporation. As a supporting structure to bitumens or other waterproofing materials, Glasfab acts in a manner



"SANDWICH" STRUCTURE CAUSED BY ROUND CLOSE-WOVEN FABRIC-BITUMENS SEPARATED BY MEMBRANE

BITUMEN-LOCKED STRUCTURE MADE POSSIBLE BY OPEN WEAVE AND FLAT FIBERS OF GLASFAB

similar to reinforcing rods in cement or concrete. It is an inert material constructed of Fiberglas yarn, and is not subject to "wicking" and other types of deterioration, providing roofing and other waterproofing materials in uniform suspension, eliminating "cracking", "alligatoring", etc., that result in eventual breakdown of the waterproofing.

Circle letter (H) on reply card.

(I) ENGINES; TORQUE CONVERTERS

Three new heavy-duty industrial engines designed for greater efficiency, performance, and operating economy are being produced by Ford Motor Company. The new units, equipped with overhead valves, bring to six the number of Ford engines especially built for industrial applications, all of them incorporating newest advancements in engine design. Also available is a new Ford multa-torque converter. It offers all the advantages of a fluid coupling plus torque multiplication, it was reported, and is designed to absorb shock overloads, prevent stalling under excess loads, and start bigger loads faster. Ford Motor Company.

Circle letter (I) on reply card.

(J) SILICA

Quartz, the crystalline form of silica has been duplicated chemically in the form of fibers, it was announced by Randolph H. Barnard, president of Glass Fibers, Inc. His company, Barnard said, has produced a highly specialized glass fiber, in the sub-micron-diameter size, that has been successfully made into a quartz paper. The initial use of the new paper will be as a high-temperature, non-deteriorating electrical insulating material. It is chemically identical with nature-found quartz, he said, which has long been regarded by science and industry as the finest insulator known.

Quartz paper, made from the new glass fibers, has high temperature resistance up to 3000 F, provides minimum electrical losses at high frequency and, in extensive tests, has proved relatively unaffected by radiation.

Circle letter (J) on reply card.

(K) CONTROL VALVE ASSEMBLY

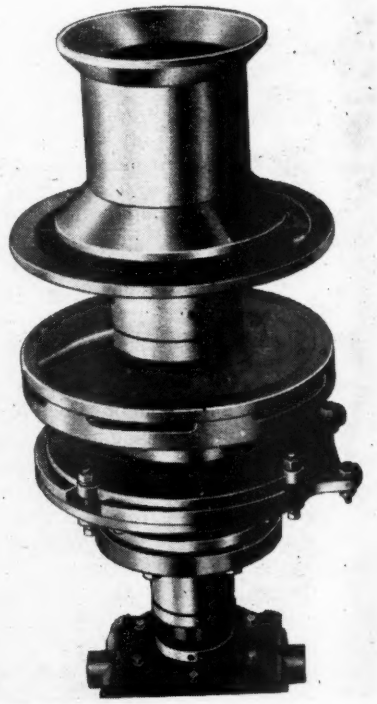
Conoflow Corporation and Paul Valve Corporation have collaborated in the development of a complete line of throttling control valves, utilizing Conoflow pneumatic cylinder operators and Paul Venturi ball valves. Since the Conocylinder operator utilizes a positioning mechanism as a component part, the assembly can be used in conjunction with standard pneumatic control instruments for automatic control, or with manual loading stations for remote manual positioning.

The streamlined Venturi passages and smooth surfaced ball provides a non-turbulent flow stream eliminating cavitation, as well as increasing capacity and improving controlability. Inherently a single seated valve, the Paul principle reduces unbalanced forces to unusually low values so that the advantage of tight shut-off may be obtained.

Circle letter (K) on reply card.

(L) AIR-TUBE CATHEAD

Now used by many drilling contractors is the Wichita air-tube cathead—a cathead that embodies the many advantages found in the air-tube disc clutch. Outstanding features of this cathead include: (1) Safety—capable of



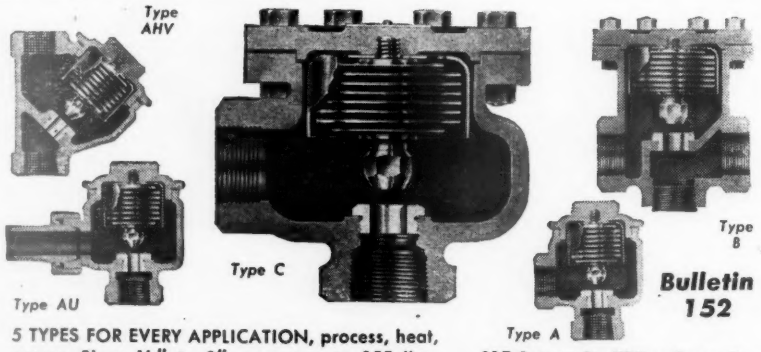
pulling all the line will safely stand without breaking . . . will not break the line unless such action is desired. (2) The same cathead can be used for either spinning or breaking out, and all parts are interchangeable. (3) Used with a new, quick-fastening line connection and a brake, this cathead can be used with a wire line as a hoist to drag in joints of pipe, pick up heavy loads, etc., instead of using manila rope on the spool cathead, and other factors. Wichita Falls Foundry and Machine Co.

Circle letter (L) on reply card.

In This Plant Nicholson Traps
SAVED 10% IN STEAM COSTS

Chief Engineer H.F.D. stated, after Nicholsons replaced mechanical traps in his plant: "Saving in steam waste cut our fuel cost at least 10%. Yet application temperatures were up 30°-40°. And relief of all air binding effected faster warm-up."

Operate on lowest temperature differential; 2 to 6 times average drainage capacity; maximum air venting. For other advanced Nicholson features send for Bulletin 152.



Bulletin 152

5 TYPES FOR EVERY APPLICATION, process, heat, power. Sizes ¼" to 2"; pressures to 255 lbs..

217 Oregon St., Wilkes-Barre, Pa.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

(M) METAL BANDS

Diamond hard metal bands are diamond-hard protective drill string collars introduced by Diamond Hard Metal Products, Inc. Made by an exclusive patented rolling process of the hardest

commercially known hard-facing materials, these bands are designed to add many extra feet of hole to the life of the drill string. These bands are easily applied to tool joints and drill collars, in the shop or in the field, by regular crews using ordinary welding techniques. The bands can be applied on badly worn joints by arc-welding flush on the outside surface, and on new joints by countersinking below the surface.

Circle letter (M) on reply card.

(N) CONDENSER CLEANER

The Lagonda division of Elliott Company has developed a new line of suspension-type condenser cleaners, which incorporate improvements in design and control. The new cleaners are especially designed for cleaning small, straight tubes and, with the proper selection of cleaning tools, are equally efficient in removing either hard or soft deposits. In operation, they are supported from overhead by means of a trolley, rope-block, or hanger. Two ball type thrust bearings, as used for years in heavy-duty Elliott refinery tube cleaners, absorb the push and pull forces imposed on the cleaner during operation. A notable improvement has been made in the control system. The control valve is actuated by a "squeeze" trigger at the base of one of the operating handles.

Circle letter (N) on reply card.

(O) ABSORPTION CELLS

Beckman Instruments has perfected a method of producing matched 10 mm pyrex absorption cells for its Model B and Model DU spectrophotometers so that these cells can be mass-produced. Each cell is individually tested under conditions exactly duplicating actual spectrophotometric procedures. Even at the relatively short wavelength of 320 millimicrons, transmission through the water-filled cell is a very high percentage of that through an air-light path, and still higher transmission is obtained, of course, at the longer wavelengths. All cells in a single shipment are matched within 3 per cent transmission at 320m and light path length of each cell held to accuracy of +0.025 mm.

Circle letter (O) on reply card.

(P) TIMING BELTS

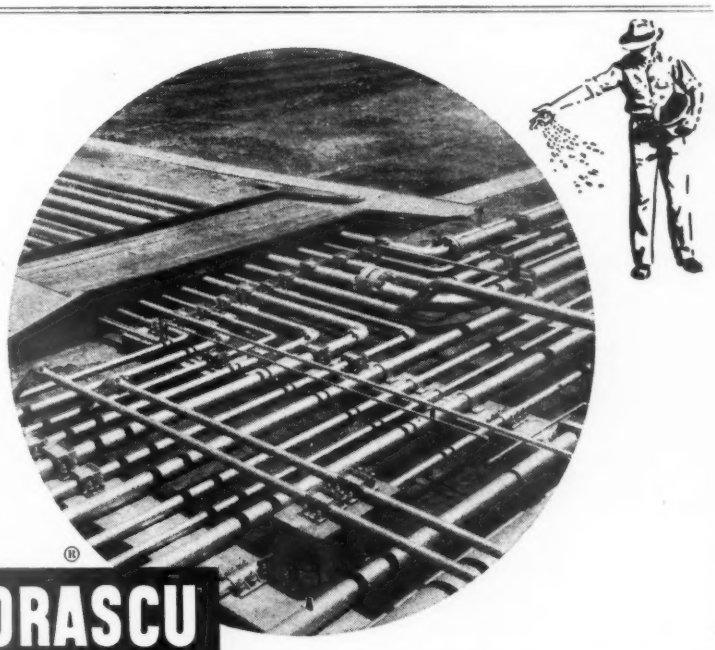
Complete efficiency and no sign of wear, in spite of oil immersion and excessive temperatures after a year of tests in which Gilmer timing belts have been driving both internal and external cam shafts of automotive engines, are reported by R. Y. Case, timing belt inventor and engineer, L. H. Gilmer Company Division of U. S. Rubber Company. First presented to the public in March 1951, the Gilmer timing belt has since been introduced to a score of industries in which it had not been tested previously. Widths range from thread-thin drives for electric clocks to belts eight-inches wide.

Circle letter (P) on reply card.

(Q) STEAM TRAP

Velan Engineering Company has announced a new design in its integrally designed universal steam trap. The Universal Velan steam trap, type by-pass is specially designed for the processing industries where continuous uninterrupted operation is essential. Two special valves are incorporated in the trap and have a unique signalling device indicating even to an unskilled operator in which position the valves are. Draining devise can be completely closed, steam and condensate can be bypassed and all internal parts of the steam trap replaced or the condensate lines can be cleaned with live steam.

Circle letter (Q) on reply card.



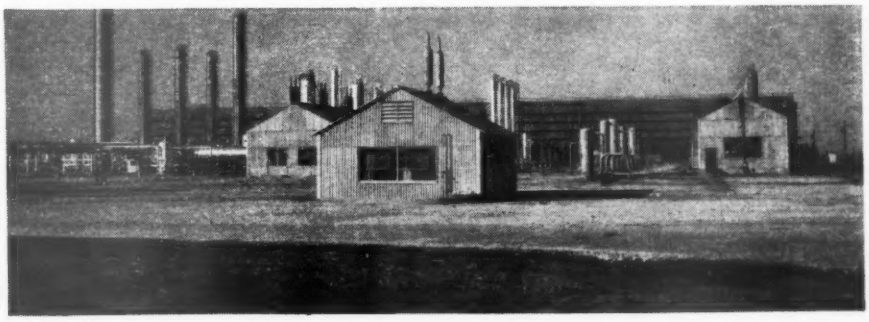
BORASCU®
WEED KILLER

NONCORROSIVE*• NONPOISONOUS
*To Ferrous Metals
NONFLAMMABLE • NONSELECTIVE

WRITE FOR LITERATURE

Removal of weeds and grasses need not be a costly problem! Borascu, when properly applied, will destroy weeds and grasses with its effective root-action; yet it is safe, inexpensive and easy to use. Removing undesirable vegetation by old-fashioned methods such as hoeing monthly, or quarterly, is an extravagant waste of manpower and money. Be thrifty ...use Borascu; a single application may keep an area cleared for 18 to 24 months!

PACIFIC COAST BORAX CO.
DIVISION OF BORAX CONSOLIDATED, LIMITED
630 SHATTO PLACE • LOS ANGELES 5, CALIFORNIA
DISTRIBUTORS LOCATED THROUGHOUT THE OIL FIELDS OF U. S. A. AND CANADA



(R) V-BELT PULLEYS

Wichita V-belt pulleys are now available in any size up to 70 in. pitch diameter and 36-in. face, for any standard belt size. The manufacturer carries many sizes in stock with the improved split type removable hub that can be quickly bored and keywayed to any desirable size. The Wichita split type removable tapered hub, the manufacturer claims, has a longer and firmer grip on the shaft than most other types of removable hubs, and is firmly bolted to both sides of the pulley hub which provides all the rigidity and stretch of a solid hub. Wichita Falls Foundry and Machine Company, Inc.

Circle letter (R) on reply card.

(S) OIL PURIFIER

A Sharples continuous centrifuge used with a unique fuel storage method, makes it possible to purify pipe line crude oil for use as a fuel in pumping station diesel engines. The non cratering purified fuel is free of dirt, tank scale, and moisture and is not re-contaminated in storage.

The continuous centrifuge, the heart of the Sharples system is powered by a two horsepower motor and is almost completely automatic, requiring only a 15 minute cleaning once a week. All safety requirements for pumping station operation are met by fireproof and explosive proof construction of unit.

Circle letter (S) on reply card.

(T) OIL-RESISTANT TAPE

A new oil-resistant tape for rapid insulation build-up on splices in large power cables has been announced by Minnesota Mining and Manufacturing Company. Designated "Scotch" brand electrical tape No. 25, it is made of synthetic rubber. The chemical-resistant qualities of the tape make it especially suitable for use in oil drilling, mining, and underground cable operations, while the 40-mil thickness and extreme stretch make possible smooth insulation wraps on irregular surfaces.

Circle letter (T) on reply card.

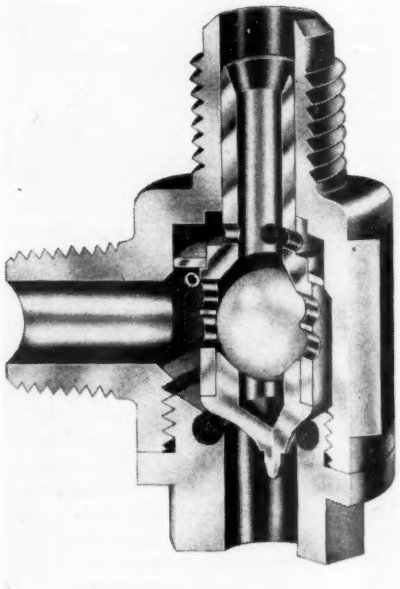
(U) DRILLING RIGS

Two new rigs, the J-1100 and J-1400, designed for medium to deepest drilling, are being introduced by Emsco Derrick and Equipment Company. They feature Emsco's "packaged design". Drawworks, selective speed transmission, compounding transmission and sand reel, optional and independent of the drawworks, are skid-mounted and packaged separately in 8-ft roadable widths. The independent selective speed transmission eliminates long chain and V-belt drives; makes possible four different types of set ups: Full flat set, one-step, two-step, and three-step.

Circle letter (U) on reply card.

(V) QUICK RELEASE VALVE

The highest degree of engineering perfection ever put into quick release valves is found in the recently perfected Wichita springless quick release valve. This is the only valve of its kind without a spring and it operates faster and lasts longer than any other such valve on the market, the company reports. It will close and seal with less than 10 lb of pressure. This valve, made of highest quality material, has a "O" ring seal that can be replaced quickly without the use of special tools. Wichita Falls Foundry and Machine Company.



Circle letter (V) on reply card.

PAINE DRILLING CO. SAYS . . .

"Thompson RATES HIGH WITH OUR CREWS

Because . . .

Thompson SEPARATORS DO A Two-Fold JOB . . ."

"FIRST, our Thompson Separator does an amazing job of reconditioning drilling muds by throughly removing shales and abrasives from this mud. Second, our separator has a Sample Machine. The Sample Machine gives us an accurate analysis of the progress of our wells by collecting foot-by-foot cuttings. For simplicity and economy alone, we feel the Sample Machine is one of the best methods yet devised for obtaining true samples."

Thompson SHALE SEPARATORS & SAMPLE MACHINES
- SELF-MOTIVATED
- RECONDITIONS MUD
- GIVES ACCURATE SAMPLES
- HAS UNLIMITED CAPACITY

SOLD ONLY THROUGH SUPPLY STORES

Thompson TOOL CO.
IOWA PARK, TEXAS

Trade Literature

Publication will be sent free.

(W) ELECTROAIRE VALVE

The Bellows Company has published a 6-page brochure describing its electroaire valve. The new valve is a complete "packaged" air control unit, consisting of a four-way directional slide valve, solenoid controls, and piston speed regulators. It is guaranteed against solenoid burnout. The electroaire valve uses tiny 8-volt solenoids, not to do the work of shifting the slide valve, but to direct the full pressure of the incoming air to the work of shifting the slide valve. A dimensional drawing for the Bellows electroaire valve is included in the brochure.

Circle letter (W) on reply card.

(X) ENGINES, PUMPS

A new 6-page brochure detailing the services of Southern Engine and Pump Company and specific examples of the various types of engines, pumps, and unitizing of such units, is now available.

Circle letter (X) on reply card.

(Y) FAN COOLED MOTORS

Construction details of Allis-Chalmers explosion-proof, fan-cooled, and non-ventilated motors are described in a new bulletin released by the company. These fan-cooled Type APZZ motors are available in ratings of 3 to 100 hp and the non-ventilated Type APKK in ratings from ½ to 2 hp. Due to the elimination of enclosed external air passages, the motors are easy to keep clean. This feature, together with an efficient cooling system, makes them suitable for use where there is dust, dirt, fly ash, rain, snow, or corrosive gases.

Circle letter (Y) on reply card.

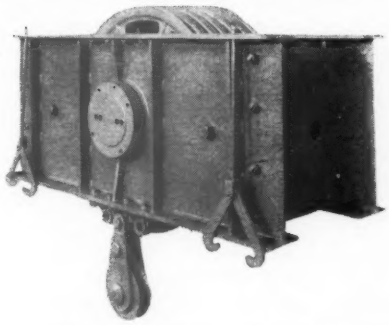
(Z) FLOW DIAGRAM

A unique composite flow diagram of a typical steam electric generating station operating at pressure between 250 and 2500 psi, prepared by the engineering staff of Edward Valves, Inc., is now available. Printed in four colors, the Edward 11 by 20 in. flow diagram illustrates with unusual clarity the functional lines of a modern power plant, the principal equipment, and a large number of valves required for controlling flow in the various piping systems. Different valve types are represented by symbols and abbreviations. All important lines carry designations, with sizes indicated in proper relationship to an 8-in. main steam line. Colored lines represent the various piping systems. Black lines indicate power plant equipment.

Circle letter (Z) on reply card.

(AA) TRAVELING AND CROWN BLOCKS

BIW Type "PN" traveling blocks and BIW Type "KN" crown blocks are described factually and briefly in a new folder offered by Beaumont Iron Works Company. Advantages of new design, capacities, and dimensions are shown



in this folder. The crown block cuts space requirements. The center pin is mounted in a box built into the beam on its center line. This construction allows two mounting positions, and by turning the block around, the deadline sheave can be set in any of four different positions to minimize Brinelling effect on the races. A row of ball bearings in bronze retainers between each of the sheaves acts as thrust bearings, resisting endwise movement and resisting the twisting effect caused by the line passing between the crown and traveling block.

Circle letter (AA) on reply card.

(AB) SIDE CRANE

Cleveland Trencher Company has just published a 4-page, 2-color bulletin on the Cleveland Model 80 Backfiller—Tamper—Side Crane. Reintroduced to the construction and utility fields at the request of pre-war users, this versatile one-man-operated machine backfills as it tamps as it travels. The folder uses text as well as action photographs to good advantage in depicting and describing the varied operations performed by the 80. Complete specifications and dimension data are clearly presented.

Circle letter (AB) on reply card.

(AC) COATINGS

Prufcoat Laboratories, Inc., has released a resistance chart showing the chemical resistance to the various types of Prufcoat coatings. It is based on the resistance of Prufcoat coatings to direct contact with the chemicals listed, both in concentrated and dilute solutions. The resistance ratings, although based on prolonged direct contact are intended to indicate the degree of resistance of Prufcoat to spills, splashes, drips and fumes of the listed chemicals.

Circle letter (AC) on reply card.

(AD) THERMOMETERS

The entire line of general-purpose and specialized Thermohms (resistance thermometers) to detect temperatures between — 325 and + 1000 F with accuracies from ± 0.018 F to ± 3.0 F are fully described and illustrated in a new 36-page catalog and buyer's guide, "Themohms, Assemblies, Parts and Accessories," just published by the Leeds and Northrup Company. To aid in the choice of the correct Thermohm, this publication features a 5-page tabular guide that indicates the Thermohm to use for each of the numerous applications in the various industries. This guide also describes how the Thermohm is used and tells where it is usually installed.

Circle letter (AD) on reply card.

(AE) IDENTIFICATION CHART

The Carpenter Steel Company, alloy tube division, has just revised its 4-color segregation chart. The chart will be useful in separating stainless steel scrap for salvage, thus increasing its value and making it more usable for industry. It will prove helpful in identifying mixed stocks of stainless steels. In addition, if there is a reasonable doubt as to the identity of the steel before starting a job, the chart will help to prevent troubles that could be caused by wrong treatment in fabrication or by improper use. The chart diagrams the stainless type numbers and describes fully how and when to use each of 11 different tests for identifying various stainless types.

Circle letter (AE) on reply card.

(AF) STEEL TANKS

Columbian Steel Tank Company has published a 36-page bulletin entitled "Bolted Steel Tanks, Erection Instructions." In explaining the proper erection procedure photographs are used to illustrate all important details. The printed word is used only for general information and to explain the procedures necessary to follow the sequence of the illustrations. Accordingly, all printed instructions are presented so that it is convenient to refer to accompanying illustrations.

Circle letter (AF) on reply card.

(AG) ROTARY PUMP

De Laval Steam Turbine Company has published a new bulletin describing its new A 313B IMO rotary pump. The pump is a general service screw-type rotary pump designed for handling petroleum products, and other light viscous fluids as required for hydraulic systems, rotary and steam atomizing oil burners, lubrication, governing systems, and similar services. Capacities to 80 gal per minute, pressures to 275 psi (continuous) and to 325 psi (intermittent). The bulletin contains a cut-away section of the pump, complete description, viscosity tables and dimensions for various frame sizes.

Circle letter (AG) on reply card.

(AH) EQUIPMENT CORROSION

The Acme-Fisher Division, Broadway Rubber Corporation and its associate, Acme-Fisher of Texas, Ltd., has published a booklet of interest to industrial firms who have problems of corrosion in equipment. The book contains 14 pages of technical and general information.

Circle letter (AH) on reply card.

(AI) ALIDADE ADJUSTMENT

To aid engineers in the field in the use and adjustment of alidades, a new 28-page pocket-size service booklet has been published by W. and L. E. Gurley. Helpful information for use of the alidade in both exploration and map making, as well as detailed instructions on stadia surveying and the use of the Beaman Stadia Arc are included in Service Booklet "C." The second half of the "C" booklet deals with alidade adjustments.

Circle letter (AI) on reply card.

(AJ) BRONZE ELECTRODES

An 8-page reprint entitled "Jobs You Can Do With Bronze Electrodes," by F. E. Garriott, manager of the weldrod department of Ampco Metal, Inc., is now available. Completely illustrated, this booklet describes the welding techniques and correct choice of bronze electrodes to be used in welding water heaters, turbine runners, cast-iron gear housings, galvanized iron exhaust stacks, bearings, dies, etc.

Circle letter (AJ) on reply card.

(AK) ESTERS

A new booklet on esters has just been published by Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation. This booklet describes the more than 30 esters that are sold by the company, their uses, physical properties, and shipping data. The booklet describes the solubility of various resins in some of the esters as well as their performance in nitrocellulose lacquers. Also included is a bibliography that lists the important references to esters in chemical literature. An important feature of this new booklet is a section covering the specifications of the esters as they are shipped. This section is complemented by a complete description of the control tests that are recommended by the company for determining specifications.

Circle letter (AK) on reply card.

(AL) SELECTION GUIDE

The American Manganese Steel Division of American Brake Shoe Company has made available a rod selection guide for Amscoating with Amsco hardfacing products. The chart is about 20 by 17 in. and contains five columns of information—basic operation, equipment parts, recommended Amsco rod, available sizes, preferred method of application. Another column describes the different types of Amsco service.

Circle letter (AL) on reply card.

(AM) FHP MOTORS

A new line of fractional horsepower motors embodying an entirely new concept of motor design and manufacture has been announced by the General Electric Company's fractional horsepower motor department. A completely illustrated bulletin describes this new motor. Designated as "Form G," the new motors are the result of nearly a decade of developmental engineering and research, and incorporate many radically different and advanced design features. According to G-E engineers who worked on the project, the Form G motor weighs as much as 51 per cent less per horsepower than the models it replaces and is considerably smaller in size.

Circle letter (AM) on reply card.

(AN) BLENDING SYSTEM

Bowser, Inc., has published a new 12-page folder describing construction, operation, flexibility, and wide application of a system for accurately blending two or more liquids in increments as low as 1/20 per cent. Sketches show simplicity and compactness as well as various types of installations. The Xacto system is adapted for use in varied kinds of industry for blending such widely different liquids as lubricating oils, coolant solutions, liquid food products, vegetable oils, and other products. Measurement, whether by weight, gaging, or by metering, can be no more accurate than the measuring method employed. For a high type of accuracy, the Xacto blending system incorporates the Bowser Xacto meter.

Circle letter (AN) on reply card.

(AO) LIFE LINE MOTOR

Design and application features of Life-Line motors (now made in ratings up to 700 hp), are described in a new 20-page booklet available from Westinghouse Electric Corporation. Life-Line motor applications in industry are illustrated and separate sections describe the special construction of motor frames, end brackets, stators, rotors, and bearings. Standard and special mountings and enclosures also are described.

Circle letter (AO) on reply card.

(AP) TRACTORS, TANKS

New tankdozers to fit into the Armed Forces high-speed tractor and tank program have just been announced by Gar Wood Industries' Findlay division. The new tankdozers are being built at the Mattoon, Illinois, plant of Gar Wood Industries, one of the largest integrated plants in the world devoted exclusively to the production of heavy duty scrapers, dozers, and other allied tractor equipment. Models can be made available for every type of tank and high-speed military tractor. Circulars describing the tank dozer are available as a guide and ready reference for those individuals responsible for procuring field equipment for the Armed Forces.

Circle letter (AP) on reply card.

(AQ) WELDING PRACTICES

A 40-page booklet titled "Recommended Practice for the Welding of Steel Castings," has been published by the Steel Founders' Society of America. This report may be used as a handy reference manual and should be kept in an office readily available to the welding area. Studies on the recommended practices for the welding of steel castings were undertaken by the Steel Founders' Society at the request of the Product Development Committee of the Society. This committee's findings indicated that certain welding procedures, as used by the foundries, could be improved. As a result the manual of recommended practices for the welding of steel castings was prepared that constitutes a basis for quality welding of steel castings. Tempil Corporation.

Circle letter (AQ) on reply card.

(AR) HYDROMATIC BRAKE

Parkersburg Rig and Reel Company has published a 56-page illustrated catalog on its new Hydromatic brake. The booklet, which contains numerous pictures, charts, and diagrams, contains also capacity curves on all sizes of Hydromatic brakes. These curves show the braking capacity of each size brake when handling a given load at a given speed. Chief improvement in the new Hydromatic brake, the company reports, is its increased capacity. Its greater capacity for handling heavier loads at lower speeds step up drilling operations and provides safer working conditions than ever before. Parkersburg Rig and Reel.

Circle letter (AR) on reply card.

(AS) SIDE-DOOR CHOKES

Otis Pressure Control has published a revised edition of its 12-page catalog on Otis removable side-door chokes and related production tools for dually-completed wells. Colored-up schematic drawings accompanying the text illustrate gas and oil flow courses, applications of the tools, and the principle of the Otis method of completing and producing two-zone wells. Cutaway illustrations showing the construction of the tools are also included, along with information on the Otis tools used to run and pull the sub-surface controls, and data and critical dimensions on the various chokes, valves, etc.

Circle letter (AS) on reply card.

(AT) BEARINGS POWDER METALLURGY

Detroit Sintered Metals Corporation has published a factual brochure on porous self-lubricating bearings and powder metallurgy. On the first page are a few pictures of intricate and simple parts that may be made by this process. Inside pages are devoted to explanation of compositions and the corresponding SAE, ASTM, and military specifications. The back cover shows approved preferred sizes.

Circle letter (AT) on reply card.

(AU) PIPE TOOLS

Beaver Pipe Tools, Inc., announces the completion of its new 1952 catalog and data book that should be of great interest to users of pipe tools. The new catalog gives readers pertinent information on the three pipe and bolt machines: Model A, B, and E; Power Units C-1 and C-2; ratchet threaders (including the well-known Beaver 26R); reamers, cutters, and other pipe tools in the hand and power classification. Four pages in the back of the catalog are devoted to the popular and instructive "Operating Guide" . . . produced by Beaver to assure users best results from pipe and bolt machines and hand tools. Fully illustrated, it quickly tells how to locate and correct pipe tool troubles. The "Operating Guide" clarifies 31 different operations.

Circle letter (AU) on reply card.

(AV) DRILLING FLUIDS

Now available is the paper, "Oil Base Drilling Fluids," which was presented at the Third World Petroleum Congress at The Hague. Written by George Miller, president of Oil Base, Inc., it presents a comprehensive analysis of oil base muds, explains their general use and special applications, gives actual production data on many wells drilled with Black Magic and is the most complete treatise on the subject to date.

Circle letter (AV) on reply card.

(AW) MACHINERY PARTS

A wide variety of cast and wrought alloy parts now being used in many industries to solve abrasion, corrosion, and high-temperature problems is described in a new 24-page booklet, "Long-Wearing Machinery Parts." More than 60 blueprints, tables, and photographs show some of the sizes and shapes in which these Haynes alloy parts are being used. The booklet is available from Haynes Stellite Company, a division of Union Carbide and Carbon Corporation. The parts described are made of the various Haynes cobalt-, iron-, and nickel-base alloys, which have had wide use as metal-cutting tools, jet aircraft parts, chemical equipment, and many types of valves and furnace parts.

For the benefit of those who may have a particular machinery part which has failed repeatedly, there are information forms included in the booklet. When filled out to describe the maintenance problem involved, this form will help assure that the right alloy is recommended for the job. Haynes Stellite Company.

Circle letter (AW) on reply card.

(AX) INSPECTION SERVICES

Preventive maintenance is increasingly important for high production in manufacturing, refinery, chemical and other heavy equipment industries. Nondestructive testing with Magnaflux, Zyglo, and other methods is one of these services which is now specially needed by many companies. To better provide the job-by-job inspection where it is needed, Magnaflux Corporation has greatly increased the national coverage of its commercial laboratories, from 5 to 11 locations. Folders are now available to briefly cover the two phases of this available inspection: laboratory inspection of parts, from one to 1,000,000 and field inspection for large objects anywhere.

This inspection by Magnaflux personnel includes experienced consultation on how best to solve problems of causes of the defects encountered, and how to establish acceptance standards.

Circle letter (AX) on reply card.

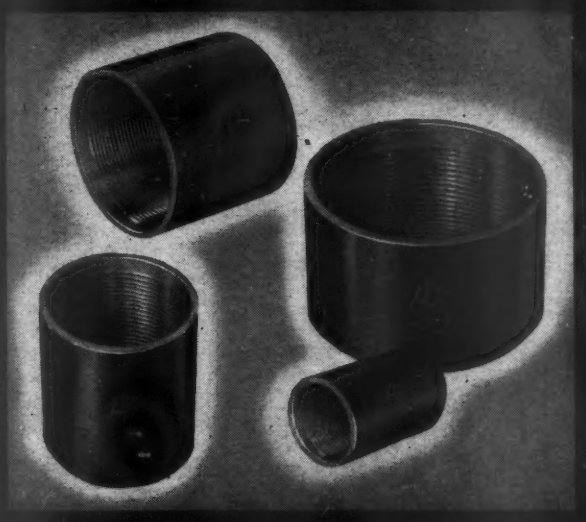
(AY) CLEANING METHODS

Scientific cleaning and processing through pH control is the subject of new literature just published by Kelite Products, Inc. Applying only to petroleum industry problems, the new brochure is well illustrated and deals with typical cleaning jobs in all phases of the industry—from rig, to refinery, to service station. The result of many years of research and in-the-field use of the recommended methods, the new Kelite literature covers such specific jobs as removal of crude oil, grease, rust, scale, paint, etc., cleaning of fuel oil or storage tanks, railroad car and truck tanks, reconditioning of oil tools, valves and machinery parts, descaling or desludging of heat exchangers, and others. Kelite Products, Inc.

Circle letter (AY) on reply card.

The character of the manufacturer

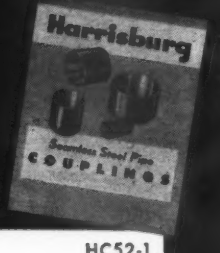
shows in the product



HARRISBURG SEAMLESS STEEL PIPE COUPLINGS

are manufactured to A.P.I. and A.I.S.I. Specifications. Harrisburg's precision manufacturing methods, the result of 99 years of experience, produce remarkable thread accuracy and uniformity of product.

We shall be pleased to mail a copy of the Harrisburg Couplings Catalog and quote prices, upon request.



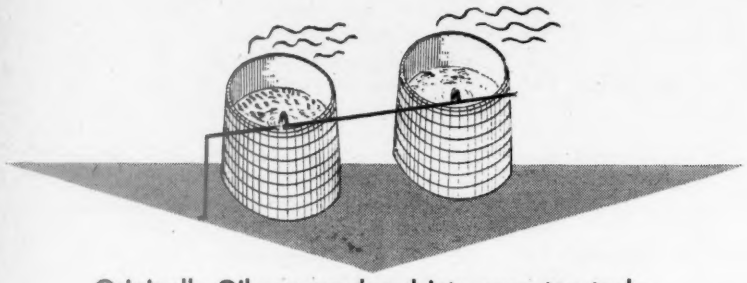
HC52-1

99 Years in Pennsylvania's Capital

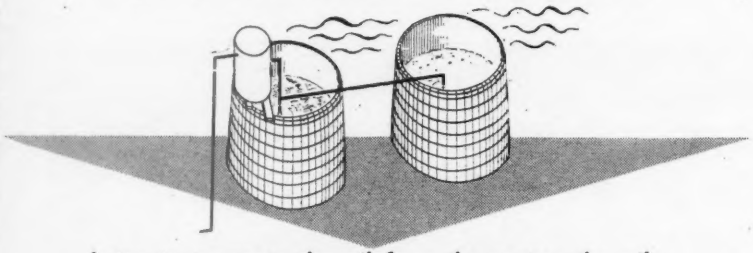
Harrisburg Steel CORPORATION

HARRISBURG 7, PENNSYLVANIA

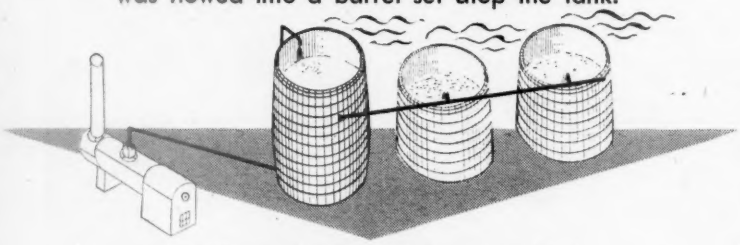
EVOLUTION OF OIL TREATING



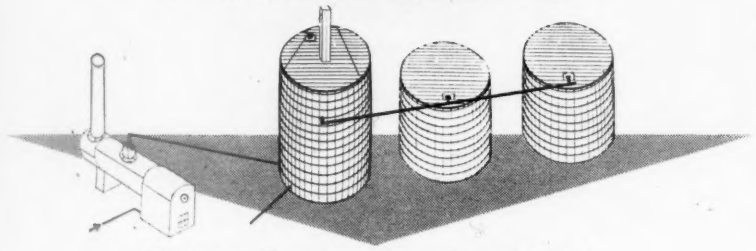
Originally Oil was produced into open top tanks.



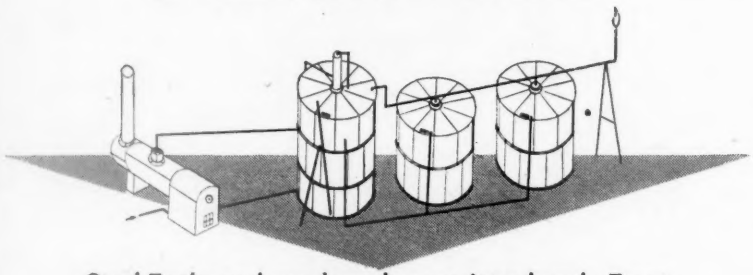
Later to separate the oil from the water, the oil was flowed into a barrel set atop the tank.



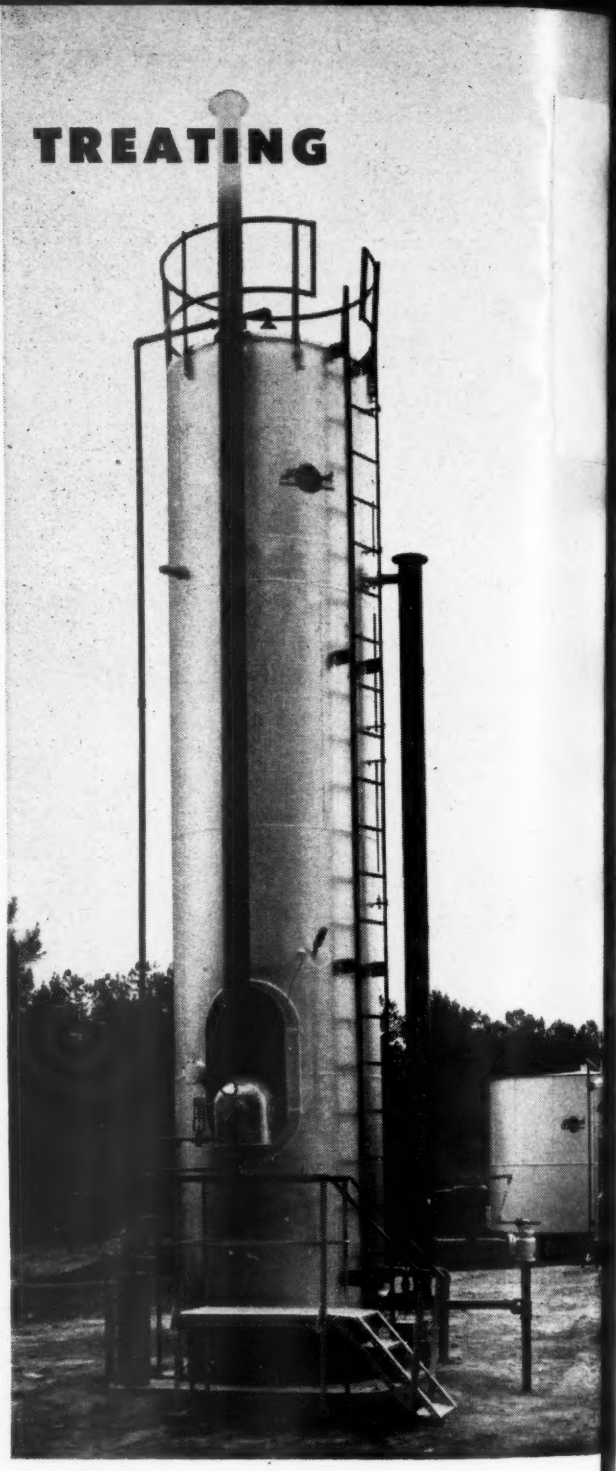
A boiler and gun barrel were added to help break the emulsified crude.



Finally roofs were put on the tanks but the valuable gases were still wasted.



Steel Tanks and gun barrels were introduced. Treating efficiency increased but great waste continued.



Today, National Treaters embody greatest water reduction efficiency; conservation of condensibles and in addition, include low pressure separation facilities in the top compartment.

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